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

**WORKPLAN**

**March 25, 2016**

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## 1. PROJECT POINTS OF CONTACT

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## 2. PROJECT LOCATION

The primary geographic focus of this project is the Jewett Brook Watershed of St. Albans Bay.

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### 3. PROJECT SUMMARY

This workplan describes the scope of work, schedule, and budget for a planned assessment of tile drainage system impacts to Lake Champlain and phosphorus loads in tile drainage in the Jewett Brook watershed (JBW) of St. Albans Bay.

Subsurface drainage is an essential water management practice on many agricultural fields, 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, reducing surface runoff by enhancing infiltration and ground water transmission. It was long believed that, despite hydrologic changes caused by implementation 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 to minimize nonpoint source pollution of surface waters.

In Vermont and across the Lake Champlain Basin (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. A recent modeling analysis in the Missisquoi River Basin showed that the addition of tile drainage to hay fields on hydrologic soil group C and D soils reduced the surface runoff component of the water balance by 25 to >40% (Stone Environmental 2011), but P-related water quality impacts that could be associated with this shift in hydrologic regime were not assessed.

The JBW represents a suitable model watershed for the study of P impacts of tile drainage systems, and the implications of tile drainage for nutrient loading reduction strategies in St. Albans Bay and elsewhere in the LCB. Jewett Brook is a low-gradient stream that joins Stevens Brook shortly before emptying into St. Albans Bay. The 8 mi<sup>2</sup> watershed is dominated by agricultural land uses, and the brook is considered to be “impaired” by sediment, nutrients, and *E. coli* bacteria attributed primarily to agricultural runoff (VT DEC 2014). More than 70% of the agricultural fields in this watershed are believed to be tile drained (VT AAFM 2015); however, the specific locations of tile systems, drainage system type (e.g., patterned versus dendritic), tile depth and outlet locations are largely unknown.

As part of the development of the new Lake Champlain P TMDL, the Environmental Protection Agency (EPA) supported a watershed modeling analysis that estimated P contributions from major land use categories. For the St. Albans Bay watershed, 65% of annual P loading to the bay was estimated to have an agricultural source, with 52% originating from cropland and the remaining 13% from pasture (EPA/Tetra Tech 2013, as cited in VT DEC 2015). While basin-specific wasteload and load allocations

have yet to be finalized by EPA, the Agency's preliminary results indicate that a 35.4% reduction in P loading from agriculture in the St. Albans Bay watershed will be needed to meet water quality standards in that lake segment (VT DEC 2015). While the modeling approach used to support load allocations and reduction targets in the Lake Champlain P TMDL does include simulation of the hydrologic impacts of tile drainage on poorly drained soils with slopes less than 5%, P transport to streams via tile drainage is not simulated (Tetra Tech 2015).

Absent the Vermont-specific information regarding P concentrations and loads from tile drainage to be generated by this study, resource managers and farmers are likely to continue to make management decisions targeted primarily to reducing P in surface runoff from agricultural fields. Improved management 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 and therefore not addressed by conventional Best Management Practices (BMPs).

The team of Stone Environmental, Inc. and Friends of Northern Lake Champlain ("Stone Team" or "Project Team") will work in close consultation with the Lake Champlain Basin Program (LCBP) to review published research documenting P loading impacts of tile drainage systems that can be related to conditions commonly found in the LCB, monitor representative tile drainage systems in the Jewett Brook watershed, estimate P loading to Jewett Brook from these tile systems, and to assess the significance of this loading to the overall P export from the JBW and similar areas of the LCB.

## 4. GOAL AND OBJECTIVES

The goal of this work is to enhance the knowledge of tile drainage effects on water quality within the LCB. To achieve this goal, the Stone Team will conduct a review of published research on subsurface drainage and phosphorus and relate this information to potential impacts on Lake Champlain; develop a GIS layer of tile drainage systems in the Jewett Brook watershed; monitor a subset of those systems for discharge and P concentration; calculate annual P loads from the monitored systems; and assess the significance of this loading to overall P export from the JBW and similar areas of the LCB. Specifically, in conducting this project the Stone Team will:

- Synthesize the current state of knowledge of P loading from tile drainage systems from published scientific literature and expert knowledge within the Lake Champlain region;
- Evaluate characteristics of the JBW and provide detailed characterization of field areas drained by 12 tile drains selected for monitoring;
- Measure total and dissolved P concentrations and flow and calculate P loads from representative tile drainage systems in the JBW;

- Analyze associations among agronomic factors (e.g., soil type, cropping system, type of drainage system, and field soil test P levels) and P concentrations and loads;
- Compute reliable estimates of annual P loads from the monitored tile systems in the JBW, including assessments of uncertainty in the calculated estimates;
- Extrapolate monitored annual P loads to the aggregate tile drainage systems in the JBW; and
- Compare the annual tile system P loads with available estimates of the total annual P load from the JBW and other drainages tributary to Lake Champlain to provide an assessment of the relative significance of tile drainage P loads in the JBW and in Lake Champlain.

Ultimately, this body of work will inform agricultural nonpoint source pollution management programs and, in particular, the need for efforts to specifically target P loading from tile drainage systems.

## 5. TASKS

The project consists of three major tasks:

- Deliver a summary report based on peer-reviewed, published literature and other quality resources documenting reported contributions of agricultural tile drainage to phosphorus loading to surface waters, and relating these impacts to the LCB;
- Monitor representative tile outlets for discharge (continuous) and P concentrations in the JBW, provide a GIS layer of the selected tile drainage systems based on best available information, as well as information more broadly on the extent and type of tiles systems in the JBW; and
- Generate an estimate of annual P loading from these tile systems and deliver a report describing nutrient loading to Jewett Brook from tile drainage systems in this sub-watershed of St. Albans Bay.

These project tasks are described in more detail below.

Throughout the project, Stone's Project Manager will serve as a single point of contact for LCBP's questions. Project personnel will communicate with landowners at the monitoring sites on a regular basis, both to obtain agronomic management information and to provide information about project results on an ongoing basis.

## 5.1. Task 1: Literature Review Examining Tile Drainage Systems

The objective of this task is to synthesize the current state of knowledge of P loading from tile drainage systems from published scientific literature and expert knowledge within the Lake Champlain Region.

### 5.1.1. Secondary Data QAPP Preparation

A Secondary Data Quality Assurance Project Plan (QAPP) will be prepared for and approved by LCBP prior to commencing work on the literature review.

### 5.1.2. Literature Review

Stone will search scientific literature by keyword and author using multiple databases, including Web of Science, the National Agricultural Library (AGRICOLA), Elton B. Stephens Co. (EBSCO) and the web search engine Google Scholar. Emphasis will be on peer-reviewed articles, but data from gray literature of suitable quality will be included to the extent available. References cited within each reviewed source will be searched for additional data. If a review article summarizes data from another study or report, we will obtain the original document so that information is collected from original sources. The search will be repeated with multiple iterations of keywords and in multiple databases until no additional references are identified.

All articles identified from search results will be screened to exclude non-relevant articles (e.g., from ecoregions, climates, or agricultural systems that differ radically from the Lake Champlain Basin). Once an article is qualified, key data will be logged into a set of spreadsheets. The spreadsheets will include fields for all important aspects of the work reported, including publication date, geographic location, scale, land use, crop and crop management, precipitation and flow, manure and fertilizer applications, soil type, slope, tillage, erosion control, nutrient management, and annual P concentrations and/or loads. Where papers generate multiple cases (e.g., unique combination of study year, study site, treatment condition, and measured constituent) as individual records, each case will be reported as a separate record.

### 5.1.3. Synthesis and Reporting

Stone will develop and submit a narrative report for LCBP review summarizing all information obtained through the literature review, including an executive summary suitable for wide distribution beyond the scientific community. The final deliverable will include: a) the narrative report and executive summary with complete list of references; b) the spreadsheets summarizing detailed information from each literature source; and c) electronic copies of all sources cited.

## 5.2. Task 2: Monitoring and Assessment of Tile Drainage Systems

Stone will apply the findings of the literature review and input from participating producers in the Jewett Brook Watershed to select 12 tile drainage systems for monitoring.

### 5.2.1. Primary Data QAPP Preparation

A Primary Data QAPP describing the procedures that will be used to ensure the quality of environmental data gathered and applied as part of Tasks 2 and 3, as described in this workplan, will be prepared by Stone and approved by LCBP prior to commencing work on these tasks.

### 5.2.2. Characterization of Tile Drainage Systems

The Stone Team will assemble and review best available geographic data for the JBW, including cropping patterns and soils data. We will use spatial information available from the Vermont Agency of Agriculture regarding the distribution of tile drainage systems in the watershed, while strictly adhering to producer confidentiality restrictions. We will provide summary 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.

Stone will apply the findings of the literature review and participating farmer input in establishing monitoring site selection criteria. Starting from the population of outlets present on the participating farm, factors considered in site selection are anticipated to include: cropping system, soil type, hydrologic soil group, soil test P, and age, layout, and depth of tile drain system. In cooperation with participating farmers, Stone will select 12 tile drainage systems for monitoring that represent an appropriate range of field conditions to the extent possible within the available population of outlets.

Detailed information will be obtained for the 12 outlets selected for monitoring. Surface topographic drainage area boundaries, drain spacing, tile depth, and system construction and age will be defined based on information provided by the landowner; soil types, slope, cropping system, and manure/fertilizer inputs within the drained area will also be documented. Phosphorus application rates and soil test P data will be assembled from nutrient management plans and interviews with the participating farmers and/or their technical service providers.

### 5.2.3. Study Implementation

To monitor flow at the tile drain outlets, Stone will create a trap in the pipeline to ensure full-pipe flow and install a pipeline flowmeter in the trap section. Specifically, Stone will excavate a section of the drain line close to the outfall; cut out a short section and replace it with rigid pipe and fittings, forming a trap; and install an in-pipe flowmeter in the trap section.



ISCO 6712 and 3700 automatic samplers will be used to collect samples of drainage water from each of the selected tile drains. 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 signal converter. The autosampler will sequentially fill four 10-L polyethylene carboys. When the first carboy is filled, the autosampler will begin dispensing sample aliquots to the second carboy, and so on until either the fourth carboy is filled or the sampling program is stopped. The flow proportional sampling frequency at each station will be adjusted seasonally with the goal of obtaining an average of approximately 5 L of sample per week (one half-full carboy), which will minimize the risk of under-sampling during large flow events (total sample capacity = 40 L). Sampling frequency will be constant during the collection of each weekly composite sample.

At each of the 12 selected tile drain outlets, flow will be recorded continuously and flow-proportional composite water samples will be collected roughly weekly to provide total and total dissolved P concentration data for the preceding week. Field visits to collect and process composite water samples will be conducted each week when the monitored tile drain is flowing. Samples will be collected on the same day each week whenever possible.

The sampling program may be influenced by weather and agronomic considerations. Stations will remain operational though anticipated dry periods, although samples will obviously not be collected if tile outlets cease flowing. During winter, flow monitoring systems will remain operational; however, autosamplers will be turned off to avoid damage. During the winter, weekly grab samples will be collected from the tile drains, if discharge occurs.

#### 5.2.4. Data Management, Analysis, and Reporting

To the extent possible among the 12 drainage systems monitored, the Stone Team will look for significant associations between tile discharge and P concentrations and the agronomic factors. Such associations will be documented by t-Test or Analysis of Variance and/or correlation and simple linear regression, depending on the factor groups being evaluated. Assessment of such associations will depend on having a sufficient number of tile systems in each relevant class to draw statistically significant conclusions.

### 5.3. Task 3: P Load Estimation of Tile Drainage Systems in the Jewett Brook Watershed

Estimation of annual pollutant load is a complex task that requires accurate measurement of both pollutant concentration and water flow, as well as careful calculation, often based on a statistical approach. Monitoring activities described in Section 5.2 will produce data on weekly total discharge and weekly mean TP and TDP concentration. Collection of flow-proportional samples ensures that the resulting composite sample is a true representation of the variability in P concentrations over the sampling period; the concentration from the weekly flow-proportional sample will represent an Event Mean

Concentration (EMC) for that week. Therefore, weekly load will be calculated simply as the product of the weekly total discharge and the weekly EMC for TP and for TDP; annual loads will be computed as the sum of weekly loads. Weekly flow, concentration, and loading data can also be aggregated to summarize flow volume, distributions of TP and TDP concentrations, and cumulative TP and TDP loads at outflows by season and over the entire monitoring period. These loads will be expressed as areal loads (e.g., kg TP/ha) based on the area draining to each tile outlet determined earlier. In principle, a representative areal load (e.g., median TP load) will be scaled up to unmonitored areas based on area.

If our sample of tile systems provides P load data that can be partitioned in categories of driving factors (e.g., loads in corn vs. grassland, in loam soils vs. clay soils, in high nutrient input vs. low input), we will extrapolate the measured load from each category to the appropriate category of all JBW tile systems. Extrapolation will be made by multiplying the median measured areal P load (kg P/ha) for the category by the area drained by tile systems in the category. If this is not possible, we will assume that the range of P loads observed in the monitored systems is representative of all systems in the JBW and extrapolate monitored annual areal P load data by multiplying the median monitored annual areal P load by the area of tile drained cropland in the JBW. Extrapolated P loads will also be calculated for the interquartile range to provide an estimate of uncertainty.

### 5.3.1. Data Management, Analysis, and Reporting

To provide an assessment of the relative significance of tile drainage P loads in the JBW, Stone will determine mean annual tributary loadings of total phosphorus derived from in-stream data collected at the USGS monitoring station where Jewett Brook passes under the Lower Newton Road. Stone anticipates using regression load estimation procedures suitable for estimating constituent loads in streams and rivers, given a time series of streamflow, additional data variables, and constituent concentration. Stone will then compare the annual P loads from tile drainage – both measured in the monitored systems and extrapolated to the JBW – to the modeled total annual P loads in surface water from the JBW.

Once a preliminary assessment of the relative significance of tile drainage P loads in the JBW is developed, Stone will assemble a meeting of local resources managers from NRCS, AAFM, ANR, the Lake Champlain Basin Program, UVM Extension, interested landowners, and others with an expressed interest in the project. We will review assumptions and present aggregated results in a manner that protects the anonymity of the participating farmers, and seek discussion and input. Potential refinement to the assessment will be considered and implemented, as appropriate, as the assessment is finalized.

## 6. DELIVERABLES

### Quarterly Progress Reports

Brief quarterly reports describing project progress will be prepared at the end of each calendar quarter. The specific dates for the delivery of each report are presented in Section 8 of this workplan.

### 6.1. Task 1: Literature Review of Published Research Examining Tile Drainage Systems

#### Secondary Data QAPP

A Secondary Data Quality Assurance Project Plan (QAPP) will be prepared for and approved by LCBP prior to commencing work on the literature review.

#### Literature Review

Stone will develop and submit a draft report for LCBP review summarizing all information obtained through the literature review, including an executive summary suitable for wide distribution beyond the scientific community. Stone will incorporate any feedback provided by LCBP and prepare a final report. The final deliverable will include: a) the narrative report and executive summary with complete list of references; and b) the spreadsheets summarizing detailed information from each literature source.

### 6.2. Task 2: Monitoring and Assessment of Tile Drainage Systems

#### Primary Data QAPP

A Primary Data Quality Assurance Project Plan (QAPP) describing the procedures that will be used to ensure the quality of environmental data gathered and used as part of the tasks described in Sections 5.2 and 5.3 of this workplan will be prepared and approved by LCBP prior to commencing work on these tasks.

#### Watershed and Tile Drain System Characterization

Stone will produce a report detailing the methods and results of the watershed and drainage area characterization. The memo 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 12 tile drain systems included in the study.

## **System Installation Report**

A technical memo, including digital photos of each monitoring installation, will be submitted following construction of the 12 tile drainage monitoring stations.

## **Monthly Monitoring Summaries**

Brief summaries of the preceding month's monitoring efforts will be submitted, including the number of samples sent to the lab from each station.

## **Monitoring and Assessment Report**

Stone will 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 12 monitored tile drainage systems will be summarized in monthly and annual statistics. Electronic files of quality checked sample concentration and continuous flow data for the monitored tile drains will also be delivered to LCBP, if desired.

## **6.3. Task 3: P Load Estimation of Tile Drainage Systems in the Jewett Brook Watershed**

### **Evaluation of Tributary Loads**

Stone will produce a technical memo summarizing our review of in-stream data collected at the USGS monitoring station where Jewett Brook passes under the Lower Newton Road and the approach for estimating total annual P loads in surface water from the JBW.

### **Preliminary Assessment of Tile Drain Load Significance**

Stone will facilitate and lead a meeting of local resources managers from NRCS, AAFM, ANR, the Lake Champlain Basin Program, UVM Extension, interested landowners, and others with an expressed interest in the project to review the preliminary assessment of the relative significance of tile drainage P loads in the JBW. A list of attendees and brief meeting summary will be prepared and submitted.

## Final Report

Results of the phosphorus load estimation for the JBW will be summarized in the project final report and will include:

- Estimates of annual P loads from monitored tile systems, including univariate statistics and estimates of uncertainty;
- An estimate of annual P loads (median and range) in tile drainage in the JBW; and
- Comparison of estimated P loads from tile drainage in the JBW with reported P loads in surface waters in tributaries to Lake Champlain.

The final report will be comprised of three sections: literature review, monitoring and assessment report, and the loading estimation results.

## Presentation to TAC

The Stone Team will make a presentation on study results to the Lake Champlain Basin Program Technical Advisory Committee at the conclusion of the study.

## 7. SCHEDULE

Work will be conducted from April 2015 through the end of calendar year 2018.

Work on the literature review will begin immediately following approval of this workplan. Installation of the monitoring facilities will take place in late-2016. The exact timing of the construction will need to be determined with input from the participating producers. Monitoring activities will be conducted for a period of 12 months. The final report for this project will be comprised of three sections: literature review, monitoring and assessment report, and the loading estimation results.

The project schedule for completion of the tasks described in Section 4 is provided in the table below.

Task	Deliverable	End Date
Workplan	Approved workplan	April 8, 2016
Quality Assurance Project Plans (QAPPs)	Approved Secondary Data QAPP (Task 1)	Within 2 weeks of contract execution
	Approved Primary Data QAPP (Tasks 2 and 3)	November 30, 2016
Quarterly Reports	Quarterly reports	Within 15 days of the end of each quarter from April 1, 2016 through July 1, 2018 (9 reports in total)
Task 1: Literature Review Examining Tile Drainage Systems	Literature review	July 1, 2016
Task 2: Assessment of Tile Drainage Systems in the Jewett Brook Watershed	Watershed and Tile Drain System Characterization Report	March 1, 2017
	System Installation Report	April 15, 2017
	Monthly Monitoring Summaries	15 <sup>th</sup> of each month
	Monitoring and Assessment Report	May 15, 2018
Task 3: Phosphorus Load Estimation of Tile Drainage Systems in the Jewett Brook Watershed	Evaluation of Tributary Loads	October 31, 2017
	Preliminary Assessment of Tile Drain Load Significance	July 15, 2018
	Final Report	September 30, 2018
	Presentation to TAC	October 2018

## 8. BUDGET AND DETAILED PAYMENT SCHEDULE

Task	Equipment and Supplies				Total Task Cost
	Personnel	Travel	Supplies	Subcontractors	
1. Literature Review of Published Research Examining Tile Drainage Systems					
Secondary Data QAPP preparation and approval	\$2,837	-	-	-	\$2,837
Literature review	\$14,253	-	-	-	\$14,253
Project communication and reporting	\$2,211	\$149	-	\$550	\$2,910
2. Monitoring and Assessment of Tile Drainage Systems in the Jewett Brook Watershed					
Primary Data QAPP preparation and approval	\$3,436	-	-	-	\$3,436
Watershed and tile drain system characterization	\$4,182	\$149	-	-	\$4,331
System installation, sampling program operation and maintenance	\$29,932	\$949	\$37,368*	\$31,250	\$99,499*
Data management and analysis, and project communication and reporting	\$5,475	\$149	-	-	\$5,634
3. Phosphorus Load Estimation of Tile Drainage Systems in the Jewett Brook Watershed					
Evaluation of tributary loads	\$28,750	\$149		-	\$28,899
Tile drain load estimation	\$30,770	\$177	-	\$1,650	\$32,597
Project communication and reporting	\$17,805	\$149	-	\$550	\$18,504
Project Total	\$139,661	\$1,871	\$37,368*	\$34,000	\$212,900

\* Includes \$12,900 for telemetry at all stations

The schedule for planned project deliverables and requested payments is provided below.

Task Number	Task / Deliverable	End Date or Period	Total Amount
1	Secondary Data QAPP	May 1, 2016	\$2,837
1	Literature Review	July 1, 2016	\$17,163
1, 3	2 <sup>nd</sup> Quarter 2016 Progress Report	July 10, 2016	\$6,500
2	Primary Data QAPP	November 30, 2016	\$3,436
2	Instrument Purchase (executed P.O.)	December 31, 2016	\$37,368
2	Watershed and Tile Drain System Characterization Report	March 1, 2016	\$4,331
2	System Installation Report	April 15, 2017	\$13,825
	4 <sup>th</sup> Quarter 2016 Progress Report	January 10, 2017	-
	1 <sup>st</sup> Quarter 2017 Progress Report and March Monitoring Summary	April 10, 2017	-
2	March Monitoring Summary	April 15, 2017	\$4,000
2	April Monitoring Summary	May 15, 2017	\$4,000
2	May Monitoring Summary	June 15, 2017	\$4,000
	2 <sup>nd</sup> Quarter 2017 Progress Report	July 10, 2017	-
2	June Monitoring Summary	July 15, 2017	\$4,000
2	July Monitoring Summary	August 15, 2017	\$4,000
3	Evaluation of Tributary Loads	October 31, 2017	\$22,399
2	August Monitoring Summary	September 15, 2017	\$4,000
	3 <sup>rd</sup> Quarter 2017 Progress Report and September Monitoring Summary	October 10, 2017	-
2	September Monitoring Summary	October 15, 2017	\$4,000
2	October Monitoring Summary	November 15, 2017	\$4,000
2	November Monitoring Summary	December 15, 2017	\$4,000
2	December Monitoring Summary	January 15, 2018	\$4,000
	4 <sup>th</sup> Quarter 2017 Progress Report	January 10, 2018	-
2	January Monitoring Summary	February 15, 2018	\$4,000
2	February Monitoring Summary	March 15, 2018	\$4,000



*Budget and Detailed Payment Schedule / 8*

Task Number	Task / Deliverable	End Date or Period	Total Amount
	1 <sup>st</sup> Quarter 2018 Progress Report	April 10, 2018	-
2	Monitoring and Assessment Report	May 15, 2018	\$5,940
3	Preliminary Assessment of Tile Drain Load Significance	July 15, 2018	\$32,597
	2 <sup>nd</sup> Quarter 2018 Progress Report	July 10, 2018	-
3	Final Report & Presentation to TAC	October, 2018	\$18,504

## 9. REFERENCES

Stone Environmental, Inc. 2011. Identification of Critical Source Areas of Phosphorus within the Vermont Sector of the Missisquoi Bay Basin. Prepared for the Lake Champlain Basin Program, Grand Isle, VT, by Stone Environmental, Inc., Montpelier, VT. Accessed at [http://www.lcbp.org/techreportPDF/63B\\_Missisquoi\\_CSA.pdf](http://www.lcbp.org/techreportPDF/63B_Missisquoi_CSA.pdf) on January 20, 2016.

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