

**Missisquoi Bay Basin Project:
Identifying Critical Source Areas of Pollution**

**First Interim Report on Modeling
November 30, 2010**

Modeling Progress, Analytical Processes Applied, and Data Collected

Stone Environmental, Inc. (Stone) is the project contractor for the phosphorus critical source area modeling project, and began work in early June 2010 after workplan approval. On August 30, 2010, the EPA and NEIWPC approved Stone's Secondary Data Quality Assurance Project Plan (QAPP, which provides a framework for data collection and analysis), via the Soil and Water Assessment Tool – Variable Source Area Model (SWAT-VSA). Stone has also convened a Project Advisory Committee comprised of local experts and stakeholders to provide input throughout the modeling process.

To date, Stone has made significant progress on many of the tasks outlined in their project task schedule (copied below with completed/in-progress tasks shown in red). Progress is described below and organized by task.

Project Objective*	Task	Date(s)	Deliverable
S	Task 1: Construction and Testing of SWAT-VSA Model	6/1/2010-8/1/2010	
R	Task 2: Development of QAPP	6/1/2010 - 8/1/2010	Approved QAPP
S	Task 3: Data Collection and Evaluation	August 2010 - 10/1/2010	
S	Task 4: Model Development and Calibration	10/1/2010 - 2/1/2011	
S	Task 5: Identify P CSAs	1/1/2011 - 3/1/2011	
S	Task 6: Field Verification of CSAs	3/1/2011 - 5/1/2011	
S	Task 7: Evaluate Management Scenarios	3/1/2011 - 5/1/2011	
S	Task 8: Evaluate Climate Scenarios	3/1/2011 - 5/1/2011	
S	Task 9: Compare Simple CSA Methods	4/1/2011 - 5/1/2011	
T	Task 10: Develop Enhanced Hydrologic Network	1/1/2011 - 5/1/2011	Enhanced Hydrologic Network Layer
T	Task 11: Prioritize CSAs	5/1/2011 - 6/1/2011	
T	Task 12: Site-Specific Modeling	5/1/2011 - 7/1/2011	
R	Task 13: Quarterly Reporting	6/30/2010 – 6/30/11	
R	Task 14: Final Report, Maps, and Data Deliverables	6/1/2011 - 8/19/2011	Final Report, SWAT-VSA Model

* S = Strategic Analysis, T = Tactical Analysis, R = Reporting

Task 1: Construction and Testing of SWAT-VSA Model

- GIS tools to aid in testing of the SWAT-VSA model were developed. These include tools for working with topographic data to generate the required Soil Topographic Index for the SWAT-VSA approach.
- Different approaches to developing and parameterizing the SWAT-VSA model on a sub-watershed of the Missisquoi Bay Basin, Hungerford Brook, have been evaluated. Stone has been focusing on the approach for delineating hydrologic response units (HRUs) via the VSA approach and for parameterizing the model to account for the VSA conceptual model. Based on testing on Hungerford Brook, Stone is close to finalizing a strategy to be applied to the broader Vermont sector of the Missisquoi Bay Basin (MBB).

Task 2: Development of QAPP

A QAPP has been developed for this project and was approved on August 20, 2010.

Task 3: Data Collection and Evaluation

- Topographic Data: Digital elevation models (DEMs) from Québec were obtained and provided to Stone. These data were merged to construct a seamless 20-m resolution dataset that will eventually be re-sampled and merged with data from the US side.
- Topographic Data: LiDAR data from the USGS was obtained for the majority of the Vermont sector of the MBB. Evaluation of these data over the Hungerford Brook areas has been extensive. Evaluation has focused on the analysis of topographic parameters using the data at a range of resolutions. This analysis will help determine the final resolution at which the SWAT-VSA model will be developed and is expected to be completed in the next few months. In addition, a seamless LiDAR-based DEM for the entire Vermont sector has been constructed at several resolutions (1.6-m, 5-m, 10-m). One or more of these DEMs will be used in the development of the SWAT –VSA model HRU structure and inputs.
- Land Cover/Land Use (LCLU) Data: Approaches for developing a “hybrid” LCLU dataset for use as input to the SWAT-VSA model have been evaluated. These approaches involve combining information from multiple sources and scales in order to obtain the best possible land use inputs covering the entire basin, at a scale practical for watershed scale modeling. The following land cover-related datasets have been used to develop this approach:
 - Land cover/use for Vermont & Lake Champlain Basin 2001
 - National Land Cover Database 2001
 - 2009 Cropland Data Layer
 - MBB Crop and & Hay dataset
 - Champlain Valley Grasslands database
 - MBB farmstead locations – farmstead footprint polygons were digitized based on an existing point layer of farmstead locations and review of aerial photos.
 - Vermont Hydrography Dataset (VHD)
 - Vermont Agency of Transportation roads data layer

The analysis of approaches has involved different strategies for combining these datasets, and construction of the datasets at different resolutions. The impact of both of these on the model HRU structure are critical, so effort has been allocated toward developing this approach. The preliminary approach for developing this dataset will be shared with PAC members for comment and approval at the PAC meeting in December.

- Soils Data, Vermont: Stone has completed data collection and analysis of soils data for the Vermont sector of the watershed, based on data obtained from the Natural Resources Conservation Service. It included construction of attributes needed for the SWAT-VSA model. In addition, a process was developed for aggregating similar soils within the watershed for the purpose of simplifying the model where warranted.
- Soils Data, Vermont: Soil phosphorus data from towns in the Vermont sector of the MBB were obtained from the University of Vermont Agricultural Testing Laboratory. These data were grouped by town and land use. A statistical analysis of this data was conducted to determine if any relationships existed between soil P and land use, town, and other soil physical and chemical

characteristics (if available). This analysis will help guide assumptions regarding initial soil P in the model.

- Soil Data, Québec: IRDA has provided Québec soils data, in both spatial and tabular formats. Currently, the spatial data is complete, and completion of tabular data is anticipated in the near future.
- Stream Channel Characteristics: Geomorphic data were collected from Vermont Agency of Natural Resources (ANR) for the various projects that have taken place in the MBB and have been merged into a geodatabase. This collection of information is being updated as current projects are completed. Quality control checks have been performed by ANR on location and variables. Research has been initiated comparing sediment and nutrient loading from channels, floodplains, and upland critical source areas in a range of watershed settings.
- Climate Data, Vermont: Precipitation and temperature data from 1980 through March of 2010 were collected for seven National Climatic Data Center stations in and near the MBB. A missing data estimation algorithm was developed and applied to each station so that each station would have a complete record for the full 30-year period. These time series will be used to generate the elevation-adjusted climate time series for the SWAT model.
- Climate Data, Quebec: 30 years of precipitation and temperature data were obtained for several monitoring sites within and around the MBB. These datasets have completed data for the period of record (1979 – 2008) and will be used in the development of the elevation-adjusted climate time series for the SWAT model.
- Agronomic Practices: Animal density data has been compiled from several sources, including a medium- and large-farm operation database, as well as county-level 2007 Census of Agriculture statistics. These data will be used to determine the appropriate levels of manure generation and application throughout the watershed.
- Agronomic Practices: Stone representatives attended a meeting of the Watershed Farmers' Alliance in August, with the objective of obtaining cooperation of farmers in providing nutrient management and agronomic practices data from their farms. While no concrete plan regarding data sharing was made, this meeting laid the groundwork for collaboration with farmers on data contributions to this project.
- Agronomic Practices: A project information packet and request for data was prepared and sent to 30 farmers that participated in a recent IJC-funded Nutrient Management Plan project conducted by Bordeaux & Bushey, with the hopes that some of the farmers would be willing to share their nutrient management and agronomic practices data.
- Point Sources of Phosphorus: The average annual discharges of all wastewater treatment facilities within the MBB were obtained from the Vermont ANR. The locations of the outfalls for these facilities were identified by VHD stream reach based on data developed as part of ANR Illicit Discharge Detection and Elimination projects and from conversations with facility operators. Locations of these point sources in Québec were obtained through LCBP and linked with Québec hydrography.

Task 4: Model Development and Calibration

- Observed Monitoring Data Collection: Observed flow, sediment, and P data was obtained from the Vermont ANR for all long term monitoring sites in the MBB from 2002 – 2005. The data obtained were the daily flux estimates at each of the sites. These data will be used in calibration and validation of the model.

- Measured daily water discharge volumes for the five tributaries to the Missisquoi River being monitored through the Short-term Monitoring Program were obtained from the USGS for the period of record. These data will be used to calibrate streamflow rates predicted by the model.
- The process of developing an HRU delineation strategy, the foundation of SWAT model development, has been tested on the Hungerford Brook watershed. Preliminary expansion to the entire study area has begun. This analysis is nearly complete, and will allow for the finalization of the model HRU delineation strategy in December.

Challenges Encountered

Thus far, challenges encountered by the contractor and reported to the LCBP have been manageable and will not ultimately compromise the integrity of the final product. The first challenge has been the collection of agronomic data at a field to farm scale. Stone has pursued several avenues to acquire this data; however, it is likely that few data, including soil phosphorus and agronomic practice information, will be obtainable. To overcome this challenge, Stone will use non-site specific data to make the best estimates possible for farms and fields in the watershed. In addition, Stone has been performing analyses to determine the sensitivity of the modeling analysis to uncertainty in inputs, such as initial soil phosphorus, to determine the relative importance of this model input.

The second challenge is in deciding the level of spatial resolution adequate for the model. High resolution LiDAR and field-level cropping data could be used to develop a very high resolution model. However, a balance must be achieved between the ability to model at this resolution and the practicality of it (from a data management, computation requirements, and application standpoint). At a very high model resolution, the computational requirements of the model are too high to allow for model calibration and validation within the project timeline. Stone is currently determining an optimal model resolution that provides sufficient detail in data outputs and is also practical for conducting watershed-scale simulations and analysis.

Summary

The project is proceeding on schedule, per the approved workplan with the contractor for this project. Acquisition of field-level data requires approval from the landowners to whom those data are applicable, and landowners remain reluctant to provide this specific information to the LCBP or its contractor. The contractor is finding ways to complete the project without these data. The LCBP anticipates reporting significant work for this project in the next interim report, due March 31, 2011.

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Appendix A: List of available data sets referenced in the interim reports supplied by electronic copy to the IJC/COR.

Because the modeling component of this project is currently in progress, the LCBP is able to provide to the IJC/COR datasets that are complete and quality controlled at this time. All other datasets referenced in this interim report that are not yet complete or quality checked will be provided in the next appropriate report.

Available Datasets

The following is a list of datasets referenced in the November 30, 2010 Interim Report on Modeling that are available at this time. These datasets have been presented to the IJC/COR on DVDs and are saved in folders, as named below.

Dataset Description	Folder name
20-m DEMs from Québec sector	QC_DEMs
1.6-m LiDAR-based DEM from the USGS	USGS_DEMs
Land cover/use for Vermont & Lake Champlain Basin 2001	LULC_2001
Vermont National Land Cover Database 2001	NLCD_2001
2009 Cropland Data Layer	Cropland_2009
MBB Crop and & Hay dataset	MBB_crops
Champlain Valley Grasslands database	CV_grasslands
Vermont Hydrography Dataset (VHD)	VHD
Vermont Agency of Transportation roads data layer	VT_roads
Vermont soils data from the NRCS	VT_soils
Daily water discharge volumes from Short-term Monitoring Program	STM_volumes