Leveraging Machine Learning to Enhance Water Quality Predictions in Small Agricultural Streams

STONE ENVIRONMENTAL
100% EMPLOYEE-OWNED

Services / Expertise
Machine-Learning Based Modeling
Agricultural Stewardship
Producer Conservation
Watershed and Water Quality Planning

Markets
State Government
Agriculture
Farmers and Crop Consultants
Conservation Districts

Project Location
Vermont

Duration
2025–2027

Project Owner
The Lake Champlain Basin Program

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Many tributaries to the Northeast Arm of Lake Champlain drain agricultural areas with low topographic relief.

AS PART OF the Lake Champlain Basin Program's Opportunities for Action plan, Stone is developing a system for more accurate and timely characterization of phosphorus (P) loading from tributaries to the Northeast Arm of Lake Champlain.

This project addresses challenges that include the lack of monitoring data for small direct drainage streams (none were monitored prior to this study) and the high uncertainty in existing P load estimates in the Northeast Arm, a 370-square-kilometer region characterized by agricultural land use and dynamic hydrological conditions.

Stone developed an innovative monitoring and modeling approach. Monitoring involves deployment of stream gauging and water sampling stations at representative sites, capturing flow rates and concentrations of total phosphorus, total dissolved phosphorus, and total suspended solids.

We are developing a dual modeling framework to integrate with this data, using Random Forest (RF) and Long Short-Term Memory (LSTM) machine learning models. Both will be trained and validated using project-specific monitoring data alongside extensive nationwide datasets from the US Geological Survey and regional monitoring programs.

These models are designed to accommodate future scenarios of land use and climate change, providing resource managers with actionable insights to design effective mitigation strategies. Preliminary analyses indicate disproportionately high P loading in small agricultural watersheds, underscoring the need for targeted interventions informed by reliable model predictions.