**Methods:**

The model links spatial data on the extent of crop fields on the Vermont side of the Lake Champlain Basin, with a field scale empirical model of phosphorus loss, the Vermont P Index (VTPI).

The VTPI is a spreadsheet-based empirical model built for farmers and regulators to use in formulating nutrient management plans. It calculates a P index score for a farm field based on estimates of losses through surface erosion, dissolved runoff, and subsurface losses through pattern tile drainage. These estimates are used to calibrate legal rates of manure application, and explore possible management scenarios.

Modelling Soil Erosion:

The VTPI requires a soil erosion rate as an input, using RUSLE (Revised Universal Soil Loss Equation) or SWAT (Soil and Water Assessment Tool). Our model implements USLE in an automated manner. The LS factor is calculated using the digital elevation models from the Vermont Center for Geographic information, and flow-routing algorithms from the pygeoprocessing module (cite). K factors were extracted from the USGS soil map, and the R factor was set to a constant of 80 based on data from (Renard et al., 1997). These data were averaged for each delineated crop field to estimate potential erosion by field. A lookup table was built for crops, crop sequence and tillage type, to extract a C factors.

Modelling Unknown Parameters:

Of the parameters required by the VT P Index, field-scale data for only a few are available.

Remaining parameters are simulated using a combination of conditional logic and probability distributions.

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| Parameter | Source | Notes |
| Vegetative Cover | Derived by VT spatial analysis lab |  |
| Soil type | Shapefile |  |
| Soil Hydro Group | Shapefile |  |
| Location, Elevation | From field delineations |  |
| Soil Test P | Modelled |  |
| Soil test Aluminum | Modelled |  |
| Manure Applications | Modelled |  |
| Fertilizer Applications | Modelled |  |
| Distance to water | Derived from Geospatial Data |  |
| Patter tile Drainage | Modelled |  |
| Vegetated Buffer | (Currently set to same as distance to water) |  |
| Manure Spreading Setback | (Currently 0) |  |
| Erosion Rate | Modelled Using Spatial Data and Simulated Parameters |  |
| Sediment trap structures | (Not included in Base scenario) |  |