

Tools to Estimate Phosphorus Reduction

Spreadsheet Tool for Estimating Pollutant Load (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies. [Taken from <http://it.tetrattech-ffx.com/steplweb/default.htm>]

STEPL Alternatives

(http://it.tetrattech-ffx.com/steplweb/STEPLmain_files/LoadReductionModels.pdf)

Models for Estimating Loads and Load Reduction

Model	Field or Watershed	Land Use Urban or Rural	Pollutant ¹	Event or Continuous	BMP ²	Data Needs ³	Level of Effort ⁴
Simple							
Simple Method	Watershed	Urban	N, P	Event	○	○	○
FHWA/ SELDM	Both	Urban	N, P	Event		○	○
SLOSS/ PHOSPH	Both	Rural	P, S	Event		○	○
Watershed	Both	Both	P	Event	○	◐	◐
Mid Range							
AGNPS	Both	Rural	N, P, S	Both	●	◐ · ●	◐ · ●
GWLF	Watershed	Both	N, P, S	Both	○	○ · ◐	○ · ◐
Detailed/Complex							
ANSWERS	Both	Rural	N, P, S	Both	●	◐ · ●	◐ · ●
GLEAMS	Field	Rural	N, P, S	Both	●	◐ · ●	◐ · ●
HSPF	Both	Both	N, P, S	Both	●	◐ · ●	◐ · ●
SWAT	Both	Rural	N, P, S	Both	●	◐	◐
SWMM	Both	Both	N, P, S	Both	●	●	●
WEPP	Both	Rural	S	Continuous	●	○ · ●	○ · ●
DSWM	Both	Rural	N, P, S	Event	◐	●	●
EPIC	Field	Rural	N, P, S	Continuous	◐	●	●
GISPLM	Watershed	Both	P	Continuous	○	◐	◐
LSPC	Both	Both	N, P, S	Continuous	●	◐ · ●	◐ · ●
P8-UCM	Watershed	Urban	N, P, S	Continuous	●	◐	◐
REMM5	Field	Rural	N, P, S	Continuous	●	●	●
KINEROS2	Both	Both	S	Event	◐	●	●
AGWA	Both	Both	N, P, S	Both	◐ · ●	◐ · ●	◐ · ●
SPARROW	Watershed	Both	N, P, S	Continuous	○	●	◐
PRMS	Watershed	Both	S	Both		◐ · ●	◐ · ●
RZWQM	Field	Rural	N	Event	●	◐ · ●	◐ · ●
Modeling Systems							
BASINS	Both	Both	N, P, S	Both	○ · ●	○ · ●	○ · ●
Toolbox	Both	Both	N, P, S	Both	○ · ●	◐ · ●	◐ · ●

Symbols: ¹ N- Nitrogen, **P** - Phosphorus S - Sediment

² ● Detailed ◐ Medium ○ Simple

³ and ⁴ ● High ◐ Medium ○ Low

⁵ Only used for buffer strip

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Simple Models

Simple Method. The Simple Method is an empirical approach developed for estimating pollutant export from urban development sites. It is used at the site-planning level to predict pollutant loadings under a variety of development scenarios. Its application is limited to small drainage areas of less than one square mile. Pollutant concentrations of phosphorus, nitrogen, chemical oxygen demand, biochemical oxygen demand, and metals are calculated from flow-weighted concentration values for new suburban areas, older urban areas, central business districts, hardwood forests, and urban highways. The method relies on the National Urban Runoff Program (NURP) data for default values. Information on The Simple Method can be found below.

<http://www.stormwatercenter.net/monitoring%20and%20assessment/simple%20meth/simple.htm>

Watershed. Watershed is a spreadsheet model developed at the University of Wisconsin to calculate phosphorus loading from point sources, combined sewer overflows (CSOs), septic tanks, rural croplands, and other urban and rural sources. It uses an annual time step to calculate total nutrient loads and to evaluate the cost-effectiveness of pollution control practices in terms of cost per unit load reduction. The program uses a series of worksheets to summarize watershed characteristics and to estimate pollutant loadings for uncontrolled and controlled conditions. Because of the simple formulation describing the various pollutant loading processes, the model can be applied using available default values with minimum calibration effort. The Watershed program can be used to evaluate the tradeoff between control of point and nonpoint sources (Walker et al. 1989).

Mid Range Models

GWLF. The Generalized Watershed Loading Functions model was developed at Cornell University to assess the point and nonpoint loadings of nitrogen and phosphorus from a relatively large, agricultural and urban watershed and evaluate the effectiveness of certain land use management practices. One advantage of this model is that it was written with the express purpose of requiring no calibration, making extensive use of default parameters. The GWLF model includes rainfall/runoff and erosion and sediment generation components, as well as total and dissolved nitrogen and phosphorus loadings. The simulation results can be used to identify and rank pollution sources and evaluate basinwide management programs and land use changes. The model also includes several reporting and graphical representations of simulation output to aid in interpretation of the results. Several versions that integrate the model with GIS and Windows-based graphical user interfaces are available. BasinSIM 1.0 is a desktop Windows version that was developed at the Virginia Institute of Marine Science, College of William and Mary (<http://web.vims.edu/bio/vimsida/bsabout.html>). An in-stream routing and sediment transport component in BasinSIM 1.0 employs the algorithms in the Annualized Agricultural Nonpoint Source Model (AnnAGNPS) to simulate sediment transport. AVGWLF is an ArcView based version developed by Penn State, which incorporates streambank erosion processes into the model (<http://www.avgwlf.psu.edu/>).

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Complex Models

SWAT. The Soil and Water Assessment Tool is a river basin or watershed scale model that can be used to predict the impact of land management practices on water, sediment and agricultural chemical yields in complex watersheds with varying soils, land use and management conditions over long periods of time. The model is continuous, physically-based, and requires specific information about weather, soil properties, topography, vegetation, and land management practices occurring in the watershed. The physical processes associated with water movement, sediment movement, crop growth, nutrient cycling, etc. are directly modeled by SWAT using this input data. SWAT is one of the supported models of EPA BASINS 3.1 system, but is not available in BASINS 4.0. The model can be downloaded at <http://swatmodel.tamu.edu>.

GISPLM. GIS-Based Phosphorus Loading Model is a simplified spreadsheet-based model to develop cost-effective strategies to reduce phosphorus loads from watersheds. Phosphorus sources can include runoff, farm animal populations and point source discharges. Simulations employ two FORTRAN programs, HYDRO and LOADS, to predict surface runoff, streams flows, and phosphorus loads. Empirical models are used to estimate the retention of phosphorus in lakes or impoundments optionally located at the downstream ends of segments. Nonpoint source control BMPs are defined for up to 12 land use categories, and point source controls for up to 3 treatment levels are defined based on effluent phosphorus concentration and flow-dependent costs. The user specifies a target load reduction as a percentage of the load with no controls and the model will allocate controls to achieve the largest reduction with minimal cost. Sediment and sediment phosphorus are not simulated in the model. A copy of the model can be obtained from <http://www.walker.net/gisplm/index.htm>.

P8-UCM. Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds – Urban Catchment Model predicts the generation and transport of stormwater pollutants in urban watersheds. Continuous water balance and mass balance calculations are performed on a user-defined system consisting of watersheds, treatment devices (such as runoff storage, treatment areas, and BMPs), particle classes, and water quality components. Simulations are driven by continuous hourly rainfall and daily air temperature time series data. The model simulates pollutant transport and removal in a variety of treatment devices (BMPs), including swales, buffer strips, detention ponds, flow splitters, and infiltration basins, pipes and aquifers. Water quality components include total suspended solids, broken into five size classes, total phosphorus, total Kjeldahl nitrogen, copper, lead, zinc and hydrocarbons. This model is available from <http://www.walker.net/p8/>.

SPARROW. SPATIally Referenced Regression On Watershed Attributes is an empirical, regression-based model using mass balance calculations to relate in-stream water quality measurements to spatially referenced characteristics of watersheds. Riverine pollutant loading rate predictions can be made for sediment, nutrients and other contaminants. Pollutants can be simulated at different spatial scales, depending on the level of detail in the datasets, and different temporal scales, either annually or for a user-defined modeling period. National level datasets such as RF1 (stream reach file), NLCD (USGS land use/land cover) and STATSGO (NRCS soil data) can be used. Estimates of pollutant loads and fate/transport characteristics are somewhat coarse due to the use of national and regional water quality datasets to develop the statistical relationship between stream processes and the model outputs. A copy of the model can be obtained from <http://water.usgs.gov/nawqa/sparrow/sparrow-mod.html>.