

# **The PPM Calculator**

**A Tool for Pasture Phosphorus Management  
and Implementation of TMDLs**

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Michael White, Hailin Zhang**

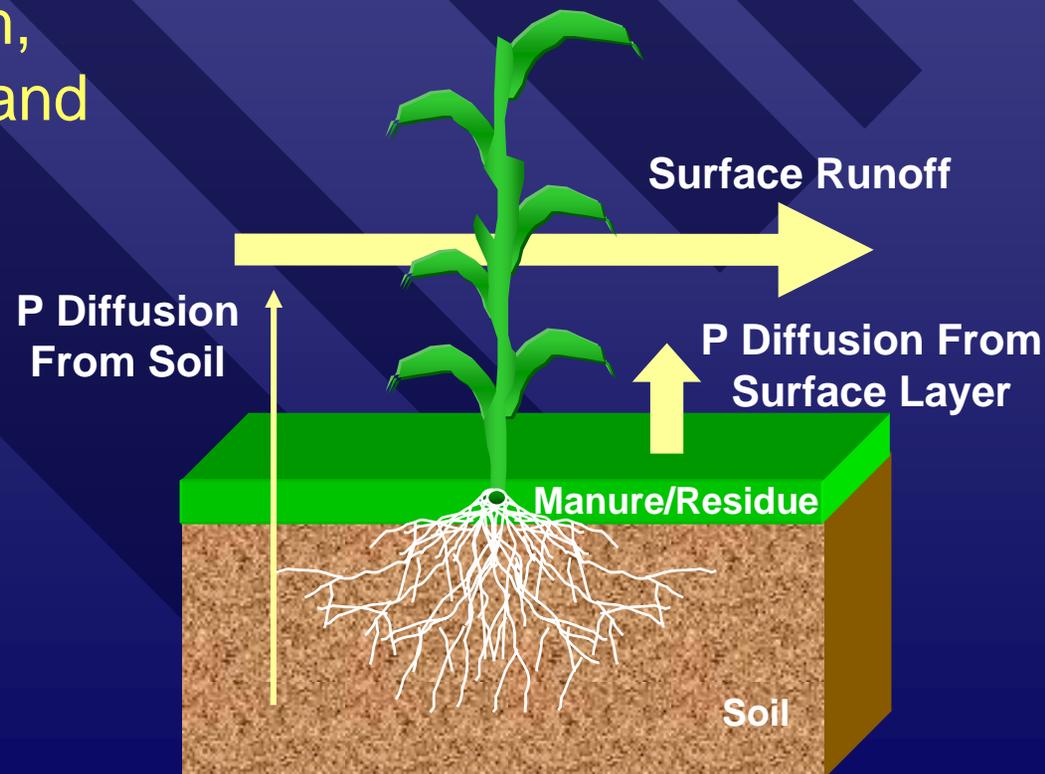
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Oklahoma State University**

# Overview

- What is the PPM Calculator - background
- Use of PPM as a tool for management of grazing and forage production
- Demonstration of the Calculator
- Use of PPM for BMP implementation to meet limits set for TMDLs
- Research needs – validation and new applications

# What is the PPM Calculator?

- A physically-based model of rainfall-runoff, crop growth, and sediment and phosphorus in runoff
- Based on the SWAT model
- Estimates crop growth, runoff, and sediment and phosphorus Loads.
- Allows comparisons of alternative management strategies.
- Can set rules to meet TMDL.



# Soil & Water Assessment Tool (SWAT)

## Comprehensive Physically Based Watershed Model



Soil & Water Assessment Tool  
[www.brc.tamus.edu/swat/](http://www.brc.tamus.edu/swat/)

Home

Software

Documentation

Publications

Education

Applications

Support

Fact Sheet

SWAT Team

Mailing List

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Links

Welcome to the official web site for SWAT

SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds.

SWAT is a public domain model actively supported by the USDA Agricultural Research Service at the Grassland, Soil and Water Research Laboratory in Temple, Texas, USA.



Upcoming Events:

Reminder:

[Forums](#) created for users to post questions

### Objective:

To predict the effect of watershed management on stream flow, sediment, nutrient and pesticide yields in large, unengaged river basins.

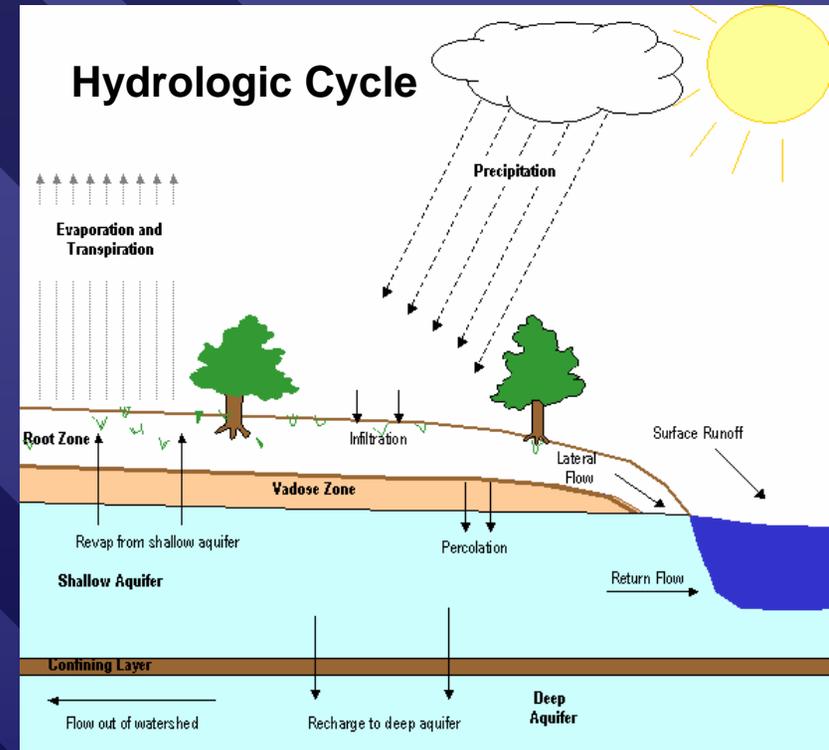
### Developed by:

USDA-ARS, Temple,  
TX

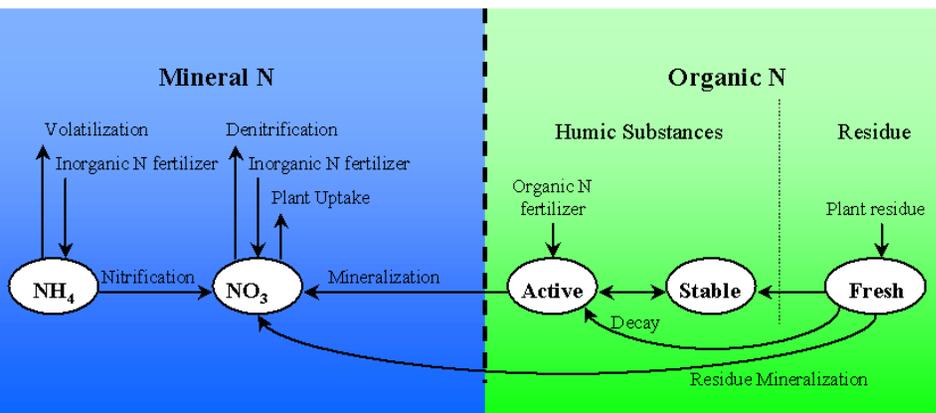
<http://www.brc.tamus.edu/swat/>

# SWAT Modeling Components

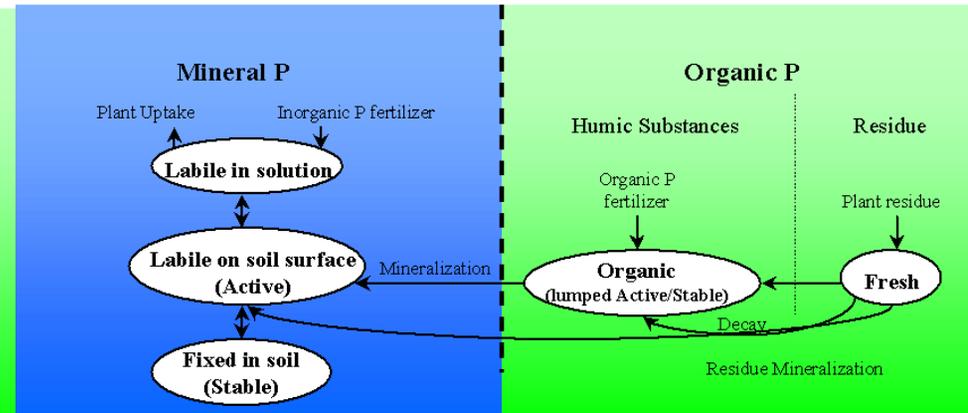
1. Climate
2. Hydrology
3. Land Cover
4. Plant Growth
5. Erosion
6. Nutrients
7. Pesticides
8. Crop/pasture Management
9. Overland flow and channel flow



## NITROGEN



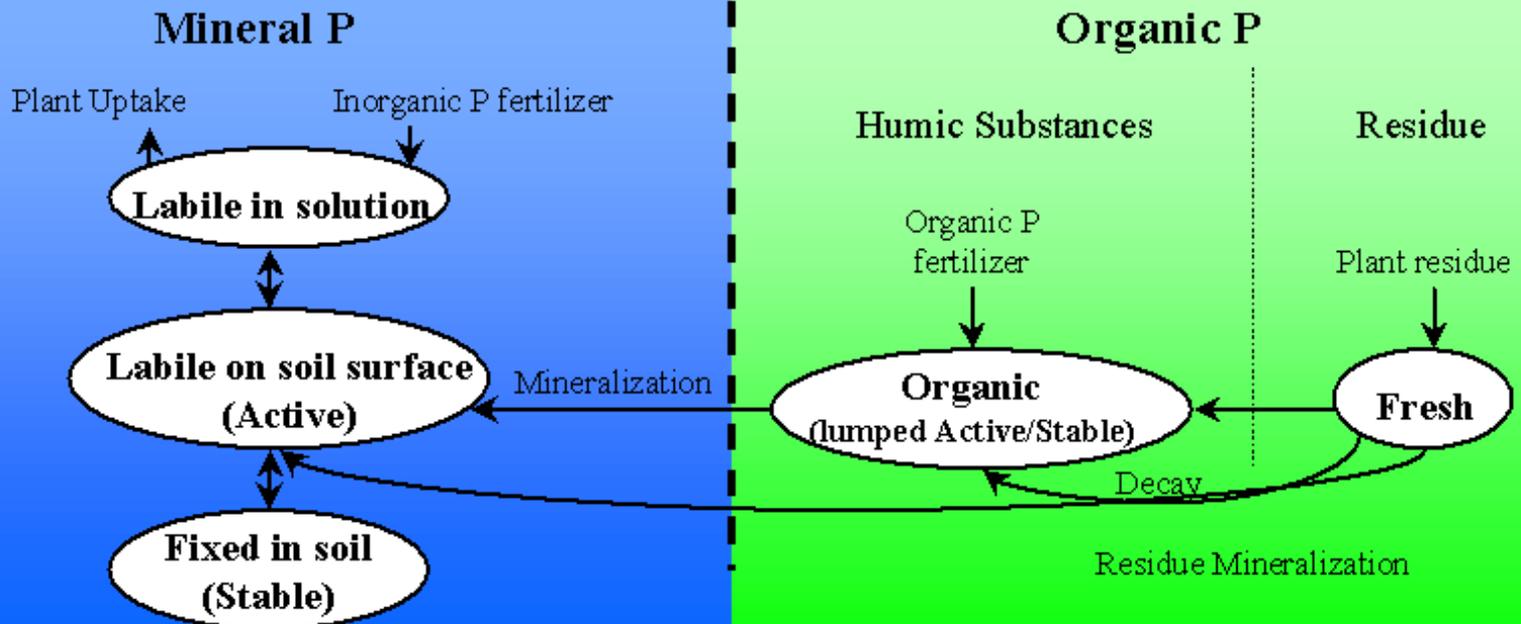
## PHOSPHORUS



# PPM Calculator

## SWAT Phosphorus Cycle

### PHOSPHORUS



# PPM data files (Invisible to the User)

- Climatic time series
  - rainfall, temperature, solar radiation
- Soil characteristics (from soils database)
  - Data files represent all possible soil names
- Forage growth characteristics
  - Cool season, warm season, mixed

# User Supplied Inputs

- **Field parameters:** location, average slope, slope length, slope and distance to stream
- **Forage type** (cool season, warm season, mixed)
- **Soil name** (predominant soil type)
- **Soil test Phosphorus**
- **Management actions** (by month)
  - Fertilizer/manure application
  - Harvesting hay
  - Grazing (stocking rate)
- **Indicators** for management of forage and livestock (minimum forage, forage yield goal)





Field Owner: Dale Dribble

Plan Developer: Rusty Shackelford

Field Description: south 40

Date MM/DD/YYYY: 10/25/2004      Field Area (Acres): 40

Field Center (UTM Coord.)  
 15678432 E      Buffer Strip Width (ft):   
 UTM 83      12355343 N      Alum Treated:

Distance to Stream (ft):

Slope to Stream (%):

P Allocation lb/acre/year: 0

Dominant Soil: CAPTINA

Forage Type: Mixed

STP (lb/acre): 275       AR     OK

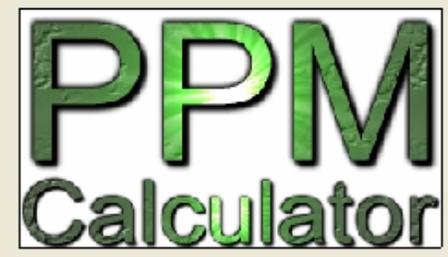
Min Dry Forage (lb/acre): 500      Ref.

Forage Yield Goal (t/acre): 8

Average Field Slope (%): 3.0

Field Slope Length (ft): 100

Month	Hay	Stocking Rate (AU/acre)		Litter (lb/acre)		Commercial (lb/acre)	
		<input type="checkbox"/> All	Ref.	N	P205	N	P205
January	<input type="checkbox"/>	<input type="checkbox"/> All	0				
February	<input type="checkbox"/>		0				
March	<input type="checkbox"/>		0	300	100		
April	<input type="checkbox"/>		0				
May	<input type="checkbox"/>		0				
June	<input type="checkbox"/>		0				
July	<input type="checkbox"/>		0				
August	<input type="checkbox"/>		0				
September	<input type="checkbox"/>		0			80	0
October	<input type="checkbox"/>		0				
November	<input type="checkbox"/>		0				
December	<input type="checkbox"/>		0				



Status and Warnings

Load Complete

# PPM Output

Created 10/21/2005 3:25:28 PM by PPM Calculator Version 2.0

Field Owner: Dale Dribble  
 Plan Developer: Rusty Shackelford  
 Field Description: south 40  
 Plan Date: 10/25/2004  
 Field Area (acres): 40  
 Field Slope (%): 3.0  
 Soil Type: CAPTINA Hydrologic Group C  
 Curve Number: 66  
 Forage Type: Mixed  
 Soil Test P (ppm): 206  
 Minimum Standing Forage (lb/acre): 500  
 Forage Yield Goal (ton/acre): 8  
 UTM Coordinates: 15678432E 12355343N UTM 83  
 Allowed P Allocation (lb/acre/year): 0.00  
 Hay Harvested (ton/acre/year): 0.0

1

Month	Hay Stocking Rate (AU/acre)	N	P2O5	Litter N	Commercial P2O5	Precip (in)	Runoff (in)	Sediment Phosphorus (t/acre)	Total Forage (lb/acre)	Available Forage (Dry ton/acre)
Jan	0.0	0	0	0	0	1.56	0.43	0.001	0.14	0.40
Feb	0.0	0	0	0	0	2.19	0.75	0.004	0.27	0.43
Mar	0.0	300	100	0	0	3.88	0.80	0.005	0.35	0.83
Apr	0.0	0	0	0	0	3.87	0.81	0.005	0.37	1.75
May	0.0	0	0	0	0	4.65	0.36	0.001	0.15	3.50
Jun	0.0	0	0	0	0	4.37	0.38	0.003	0.17	5.79
Jly	0.0	0	0	0	0	2.64	0.02	0.000	0.01	7.61
Aug	0.0	0	0	0	0	3.77	0.03	0.000	0.01	8.08
Sep	0.0	0	0	80	0	3.34	0.21	0.001	0.08	8.08
Oct	0.0	0	0	0	0	3.67	0.31	0.003	0.13	8.08
Nov	0.0	0	0	0	0	3.87	0.41	0.002	0.16	0.40
Dec	0.0	0	0	0	0	2.45	0.49	0.002	0.20	0.40

Annual Totals 300 100 80 0 40.26 5.00 0.030 2.06

2

3

WARNING: PPM Calculator predicts this management scenario will exceed the allowable phosphorus load by 2055603.2%

# PPM Output

Created 10/21/2005 3:25:28 PM by PPM Calculator  
Version 2.0

Field Owner: Dale Dribble  
Plan Developer: Rusty Shackelford  
Field Description: south 40  
Plan Date: 10/25/2004  
Field Area (acres): 40  
Field Slope (%): 3.0  
Soil Type: CAPTINA Hydrologic Group C  
Curve Number: 66  
Forage Type: Mixed  
Soil Test P (ppm): 206  
Minimum Standing Forage (lb/acre): 500  
Forage Yield Goal (ton/acre): 8  
UTM Coordinates: 15678432E 12355343N UTM 83  
Allowed P Allocation (lb/acre/year): 0.00  
Hay Harvested (ton/acre/year): 0.0

Month	Stocking Rate (AU/acre)	Litter		Com. Precip		Runoff		Sediment (t/acre)	P (lb/acre)	Forage (Dry ton/acre)
		N	P <sub>2</sub> O <sub>5</sub>	N	P <sub>2</sub> O <sub>5</sub>	(in)	(in)			
Jan	0.0	0	0	0	0	1.56	0.43	0.001	0.14	0.40
Feb	0.0	0	0	0	0	2.19	0.75	0.004	0.27	0.43
Mar	0.0	300	100	0	0	3.88	0.80	0.005	0.35	0.83
Apr	0.0	0	0	0	0	3.87	0.81	0.005	0.37	1.75
May	0.0	0	0	0	0	4.65	0.36	0.001	0.15	3.50
Jun	0.0	0	0	0	0	4.37	0.38	0.003	0.17	5.79
Jly	0.0	0	0	0	0	2.64	0.02	0.000	0.01	7.61
Aug	0.0	0	0	0	0	3.77	0.03	0.000	0.01	8.08
Sep	0.0	0	0	80	0	3.34	0.21	0.001	0.08	8.08
Oct	0.0	0	0	0	0	3.67	0.31	0.003	0.13	8.08
Nov	0.0	0	0	0	0	3.87	0.41	0.002	0.16	0.40
Dec	0.0	0	0	0	0	2.45	0.49	0.002	0.20	0.40
<b>Totals</b>	<b>0</b>	<b>300</b>	<b>100</b>	<b>80</b>	<b>0</b>	<b>40.26</b>	<b>5.01</b>	<b>0.027</b>	<b>1.94</b>	

**WARNING: PPM Calculator predicts this management scenario will exceed the allowable phosphorus load by 223%**

# PPM Calculator

## Pasture Management Tool

- Designed for field personnel and producers – inputs are readily available
- Insulates the user from the complexity of SWAT by formatting inputs and interpreting output
- Allows user to try alternative management scenarios:
  - Grazing management: select minimum biomass, change stocking rate by month (or minimum biomass), determine fertilizer rate and type by month
  - Manage forage: set yield goal, harvesting dates, fertilizer rate and timing, and stocking rates
  - Fertilizer: change type, amount, and dates

# PPM Calculator (cont.)

- PPM Calculator is not new science - an application of existing, proven technology (the SWAT model).
- SWAT is a widely accepted - used extensively by hydrologists and engineers since 1994 in the USA and around the world
- Similar applications-based models can be developed from SWAT by simplifying the system:
  - Preload appropriate databases
  - Set up one HRU to represent only one field
  - Focus on the choices of interest
  - Simplify user interface and interpret the output

# PPM Calculator – The Extras

- Tamper proof code and data files to prevent the execution of a corrupted or altered PPM Calculator or input data file.
- Smart input fields assist the user in parameter estimation.
- Warnings and messages alert the user to common mistakes.
- References tables and calculators aid the user in selection of
  - Stocking rates
  - Minimum available forage
  - Fertilizer application rates

# PPM Calculator TMDL Implementation Tool

- Calibrate the SWAT model to the basin of interest.
- Use calibrated parameters in the PPM Calculator.
- Set targets edge-of-field loading
- User tries management alternatives to see what will meet the target.

# PPM Calculator – Future Work

- Collection of Edge-of-field Data
- Comprehensive Validation
- Additional Best Management Practices
  - Buffer Strips
  - Others....
- Alum Treated Litter
- Delivery Ratio – P Loading to Receiving Water Body
- Economics
- Row Crops & Small Grains
- Regional Validation

# Currently on the Drawing Board

- Table showing what can be changed in PPM
- P movement through the model – p pool diagram from SWAT
- Calibrate to other basins
- Characterize Interactions in PPM
- Guidance for use of PPM in TMDL and crop management



**Questions?**