

Modeling the Short and Long Term Impact of Best Management Practices in an Agricultural Watershed

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Presentation Overview

- Need for BMP simulation
 - Black Creek Project (1973-1984)
 - Black Creek Project Revisited
- Proposed BMP simulation measures
 - Short-term impact
 - Long-term impact
- BMP simulation preliminary results
 - Short-term impact

Need for Hydrological Model Simulation of BMPs

- To provide insight on water quality and monetary benefits received from implementation of a practice for the short and long term.
- A standard BMP simulation protocol for the Soil and Water Assessment Tool (SWAT) has not been developed.

The Black Creek Project (1973-1984)

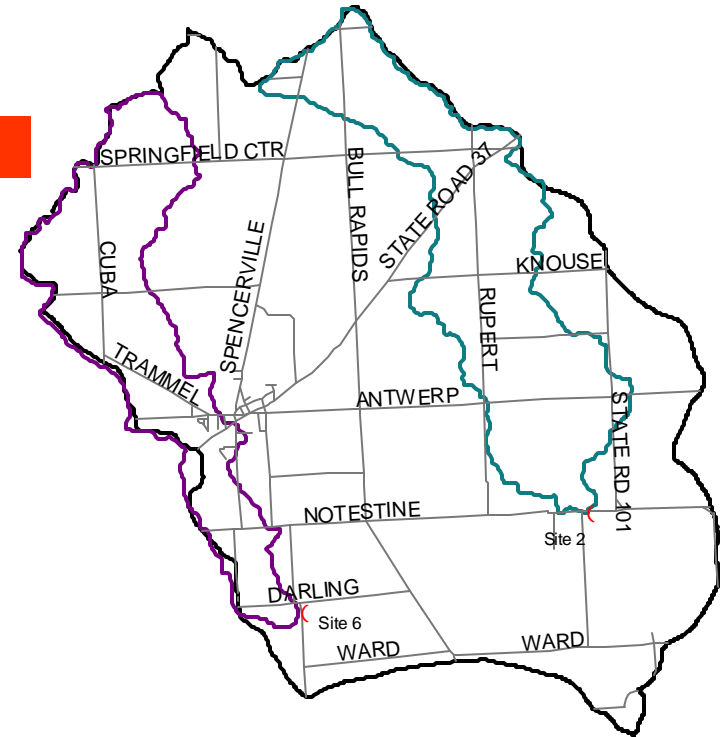
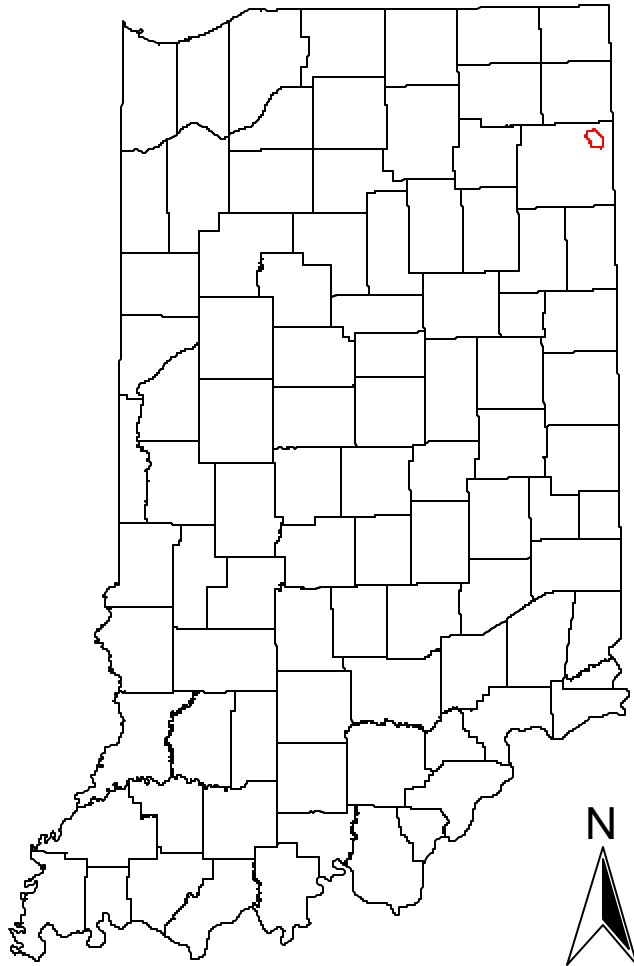
- Studied relationship between agricultural practices and BMPs to improve water quality.
- Funded by US EPA and administered by a group of Purdue University scientists.
- Centered on reducing sediment and phosphorus leaving watershed.






Black Creek Project Purpose (1973-1984)

- ❖ To find to what extent soil and water conservation techniques, applied throughout the watershed, would improve water quality of surrounding waterways, including Maumee River and Lake Erie.



The Black Creek Watershed



-  Water Quality Sample Sites
-  Roads
-  Smith-Fry subwatershed
-  Dreisbach subwatershed
-  Black Creek Watershed

Why Look Back?

- Water quality measures implemented in project are widely used today.
- Long-term impact of implemented BMPs is not known.

Currently Used BMP Simulation Techniques

- **ANSWERS**

A routine simulates ponds, parallel tile-outlet terraces, grassed waterways and field borders (Beasley and Huggins, 1982).

- **APEX**

Model can be used to evaluate various land management strategies including terraces, grassed waterways, and filter strips (Williams, 2000).

- **AnnAGNPS**

Filter strips simulated by increasing the roughness factor and adjusting the slope length to represent the strip length (Yuan, 2002).

Past Studies of BMP Simulation in SWAT

- Riparian areas simulated by modifying the channel cover factor and channel erodibility factor to model the cover density and erosion resistance ability of the structures (Vache et al., 2002) .
- Grade stabilization structures modeled by modifying the slope and soil erodibility factor (Santhi et al., 2002).
- Filter strip trapping efficiency for sediment, nutrients and pesticides computed in SWAT.

$$trap_{ef} = 0.367 * (width_{filtstrip})^{0.2967}$$

(Neitsch et al., 2002).

Methodology for BMP simulation

- Parameters to modify chosen by reviewing published literature.
- Parameters reviewed with members of the SWAT development team.
- A list of values to use for the short-term and long-term conditions was compiled.

Methodology for Model Runs

- SWAT runs performed for grassed waterways, parallel terraces and without BMPs.
- Data used - 30m DEM, 1978 land use, SSURGO soils, and SWAT simulated weather.
- Calibration, validation and sensitivity analysis was not performed for the preliminary runs.

BMP Simulation Parameters

- Grassed Waterway

Parameter	Without BMP	With BMP
CH_COV	0.00	0.00
CH_EROD	0.00	0.02
CH_N2	0.014	0.24

- Field Border

Parameter	Without BMP	With BMP
CH_COV	0.00	0.00
CH_EROD	0.00	0.02
CH_N2	0.014	0.20

BMP Simulation Parameters

- Grade Stabilization Structure

Parameter	Without BMP	With BMP
CH_S2	Use SWAT default (0.006)	Reduce by 75% (0.0015)

- Parallel Terrace

Parameter	Without BMP	With BMP
SLSUBBSN	Use SWAT default (121m)	Reduce by 75% (31m)
USLE_P	1.00	0.10
CN2	Use SWAT default	77.00

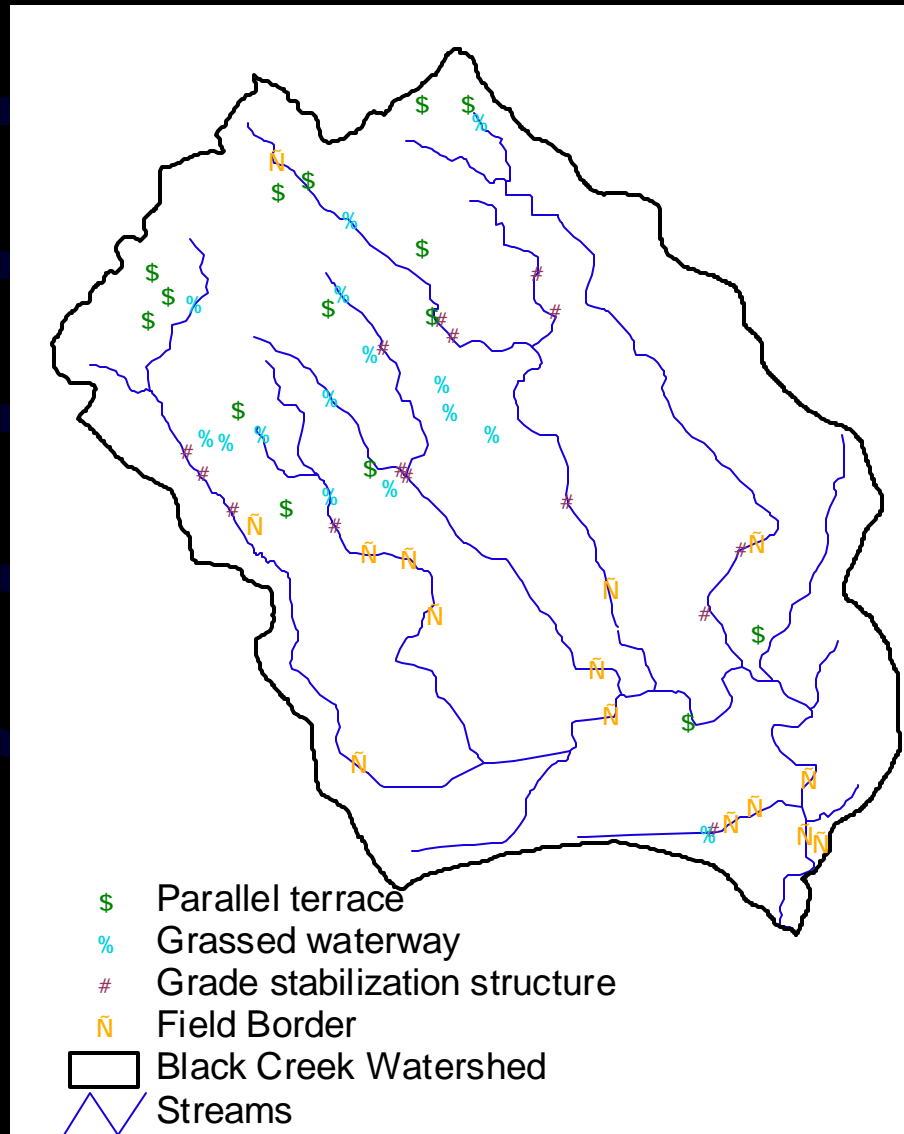
Simulation of BMPs in Varying Conditions

- Evaluation tool developed to compute the current condition and functionality of a practice based upon comparison to initial design parameters and physical inspection (Bracmort, 2003).
- Simulation for varying conditions will use adjusted parameter values based on results from the evaluation tool.

BMP Long-Term Simulation

- Evaluation tools developed based on
 - 1.) characteristics found to be the most important to the long-term functionality of the practices,
 - 2.) USDA NRCS design standards, and
 - 3.) recommendations from experienced conservationists (Bracmort, 2003).
- Evaluation tool rates BMPs on a 3-point scale.
 - 3 = fully functional
 - 1 = no longer performs

Application of Developed Evaluation Measures to the Black Creek Watershed



Grade Stabilization Structure



Grassed Waterway



Parallel Terrace



Application of Developed Evaluation Measures to the Black Creek Watershed

Practice Type	Mean Score	Maximum Score	Minimum Score
Grassed Waterway	2.41	2.81	2.13
Grade Stabilization Structure	2.34	2.80	1.71
Field Border	2.73	3.00	2.27
Parallel Terrace	2.05	2.50	1.25

Application of Developed Evaluation Measures to the Black Creek Watershed

- 33% of the practices randomly selected for evaluation no longer exist (Bracmort, 2003).
- Evaluation results suggests grassed waterways and field borders may have a longer impact on water quality than grade stabilization structures and parallel terraces.

Long-Term BMP Simulation Parameter Values

- Grassed Waterway

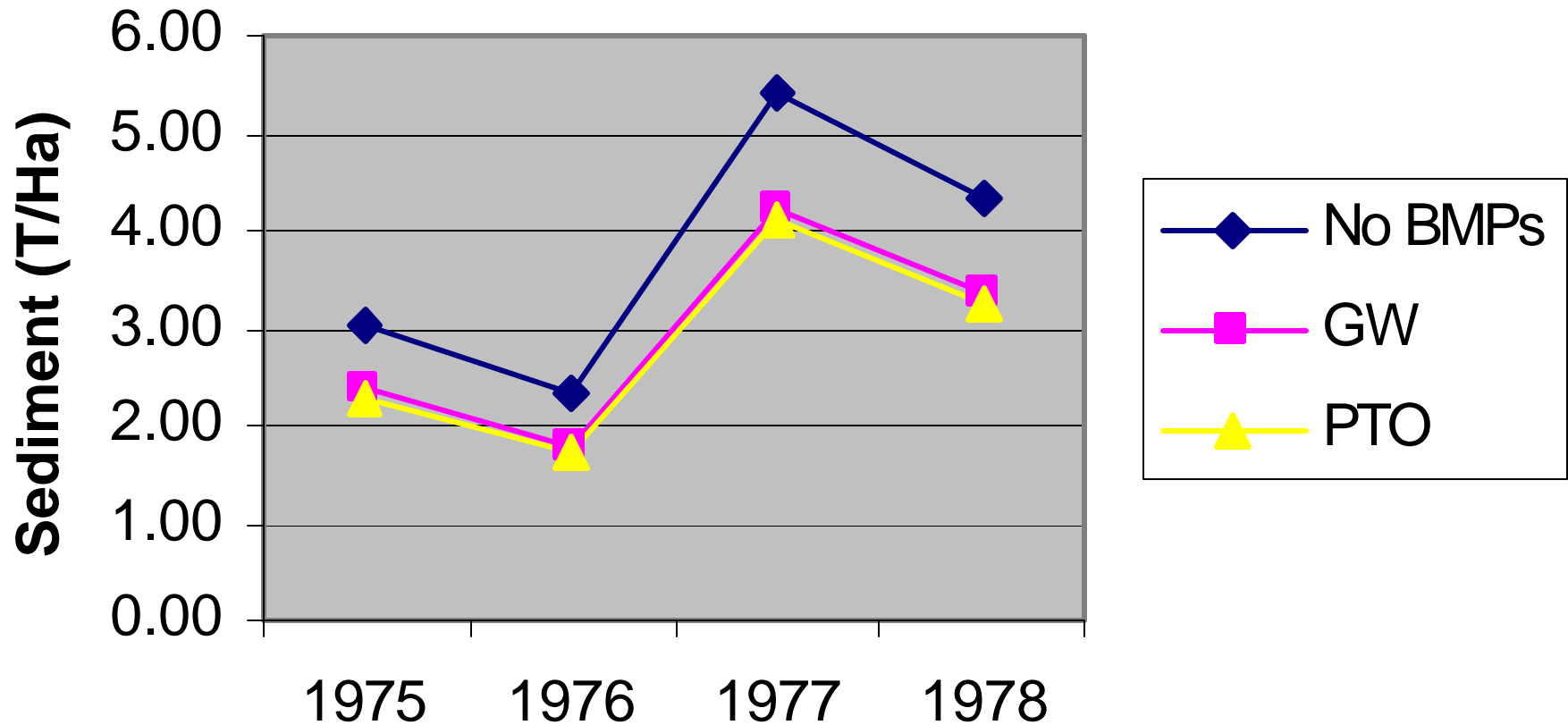
Condition Score	Parameter Values
Good (3)	Assume good cover, a low erodibility rate, and assign Manning's N according to the vegetation of the waterway.
Fair (2)	Assume fair cover, a moderate erodibility rate, and assign Manning's N according to the vegetation of the waterway.
Poor (1)	Assume poor cover, a high erodibility rate because of the poor cover, and assign Manning's N according to the vegetative cover of the waterway.

Long-Term BMP Simulation Parameter Values

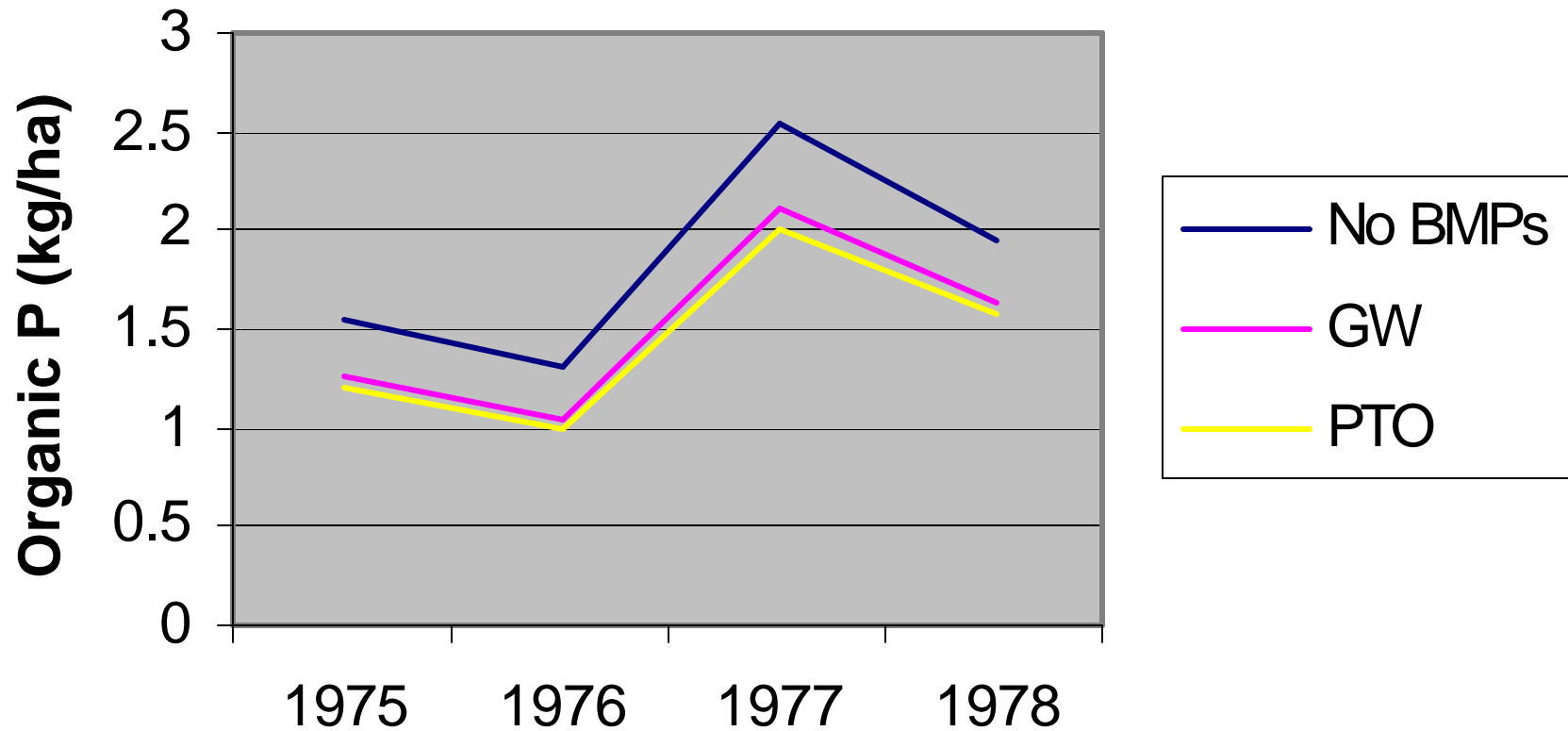
- Parallel Terrace

Condition Score	Parameter Values
Good (3)	Assume the slope length is reduced by 75% or more, the conservation practice factor reflects a low sedimentation factor, and curve number is appropriate for the area of interest .
Fair (2)	Assume the slope length is reduced by 50%, the conservation practice factor reflects a moderate sedimentation factor, and curve number is appropriate for the area of interest.
Poor (1)	Assume the slope length is reduced by 25%, the conservation practice factor reflects a high sedimentation factor, and curve number is appropriate for the area of interest.

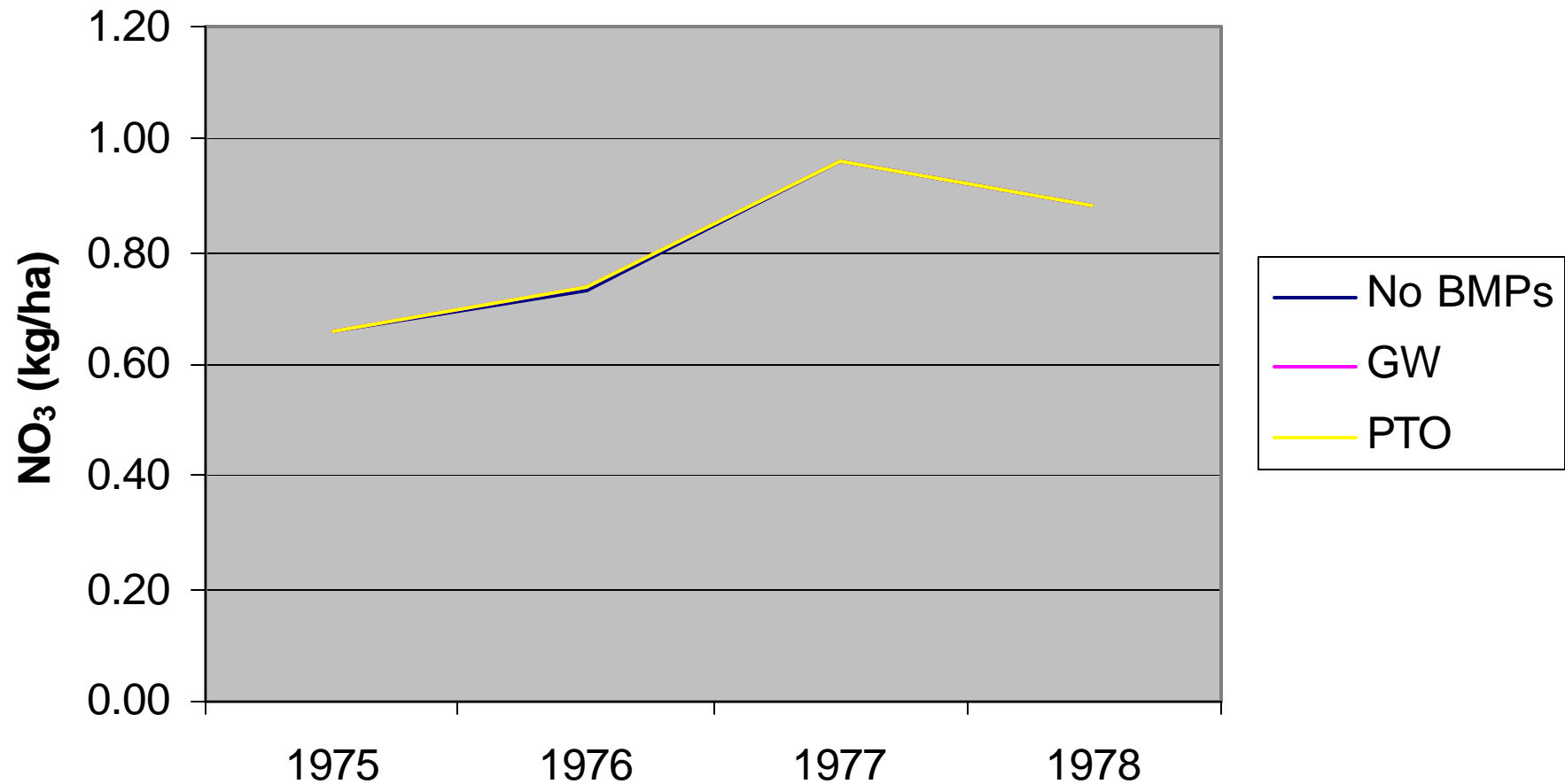
Predicted Yearly Sediment Loading for 1975-1978



Predicted Yearly Organic P Loading for 1975-1978



Predicted Yearly NO₃ Loading for 1975-1978



Future Work

- BMP simulation method will be conducted on practices in two sub-watersheds of the Black Creek watershed.
- SWAT runs will include simulations for grassed waterways, grade stabilization structures, field borders and parallel terraces.

Issues of Concern

- BMP simulation is for an entire subbasin. HRU location is not known.
- Placement of the BMP and the number of BMPs implemented within a subbasin can greatly affect the output results.

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The Black Creek Project

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