Tile drainage in SWAT

(Plus a little about our Lake Erie Basin projects)

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Outline

- Hydrologic effects of tile drainage in Midwest landscapes
- Factors controlling tile flow
- SWAT drainage routines
- Remaining needs
- Our SWAT project in the Upper Maumee River Watershed

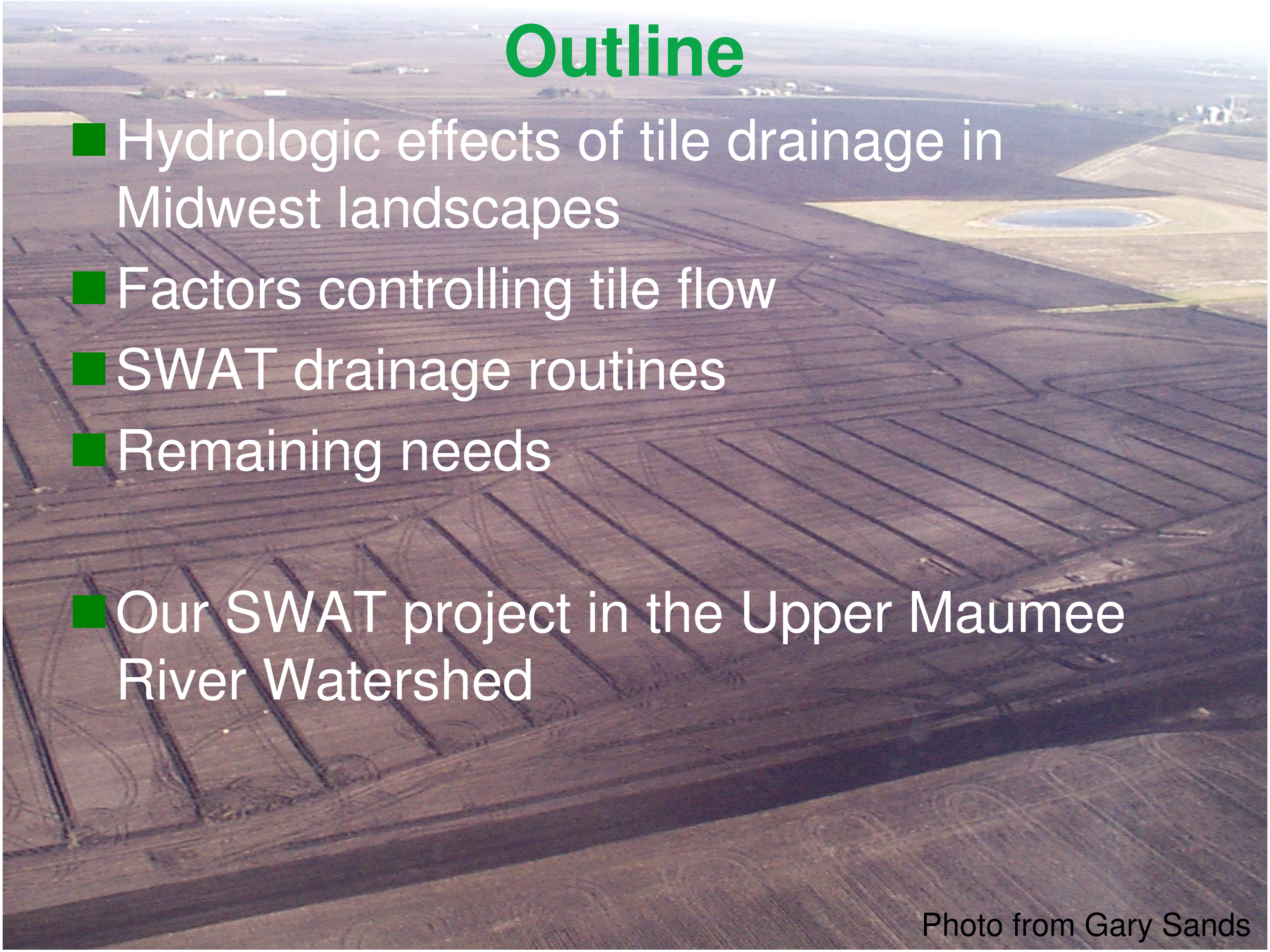
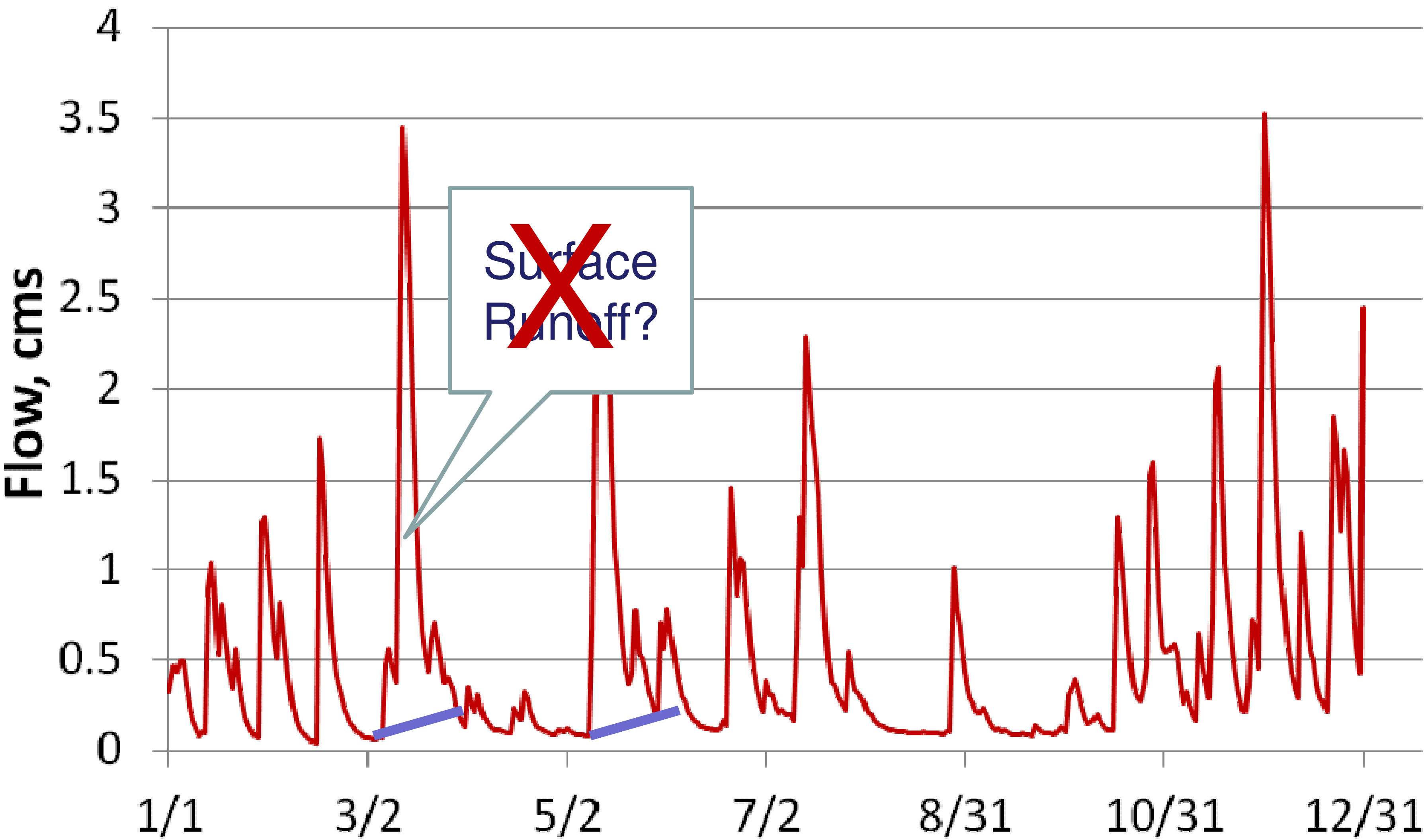


Photo from Gary Sands

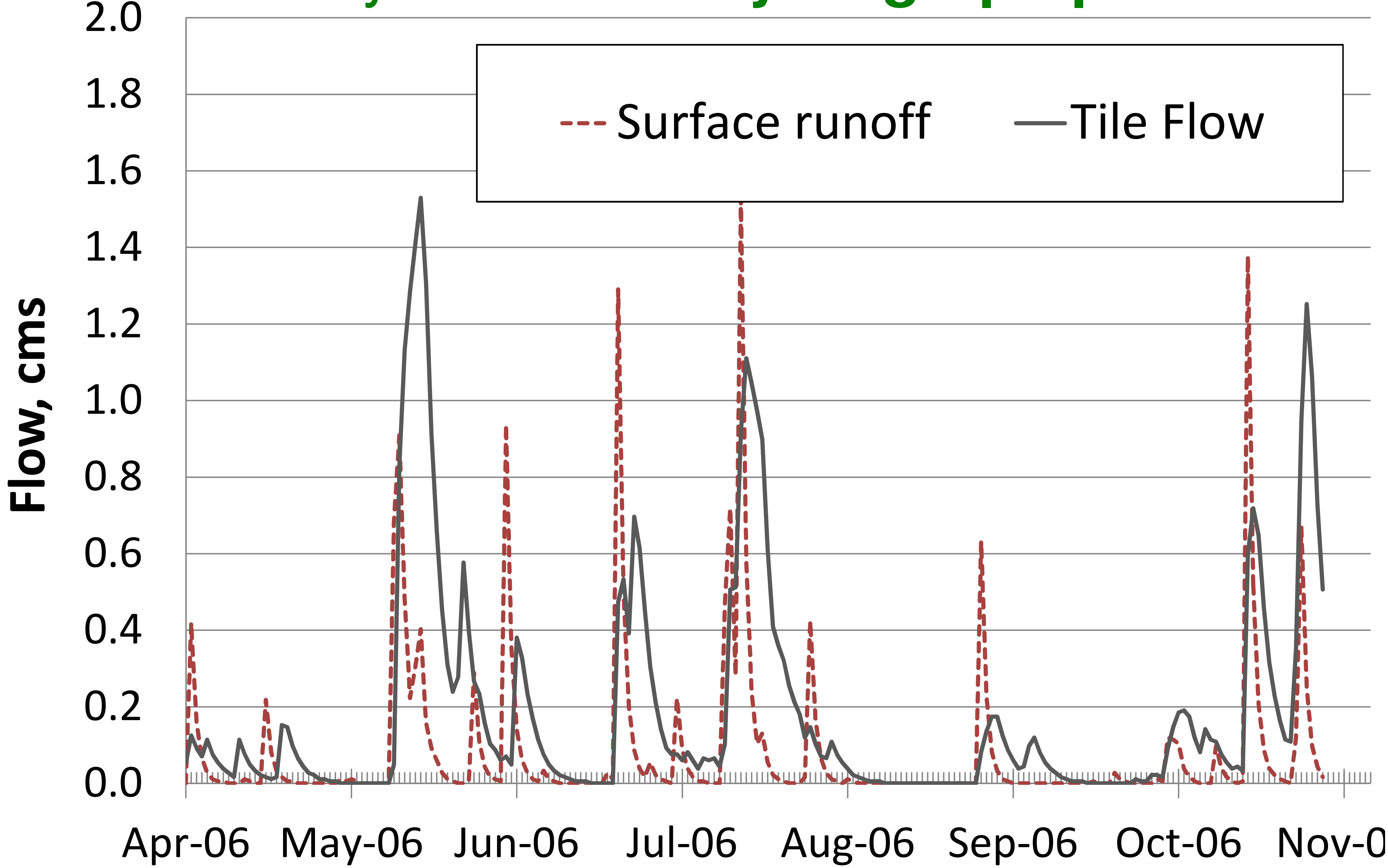
Hydrologic effects of tile drainage in Midwest landscapes

- Tile drainage is more than 50% of flow in many watersheds
- Boles reviewed field-scale studies and found average tile flow to be 23% of precipitation
  - Total streamflow 33% of precipitation (in Ind.)
- Only a portion of a watershed is drained
  - If 50% tile-drained, avg 12%
- Highly variable, depending on drain spacing, depth, soils, etc.

Tile drain flow is stormflow



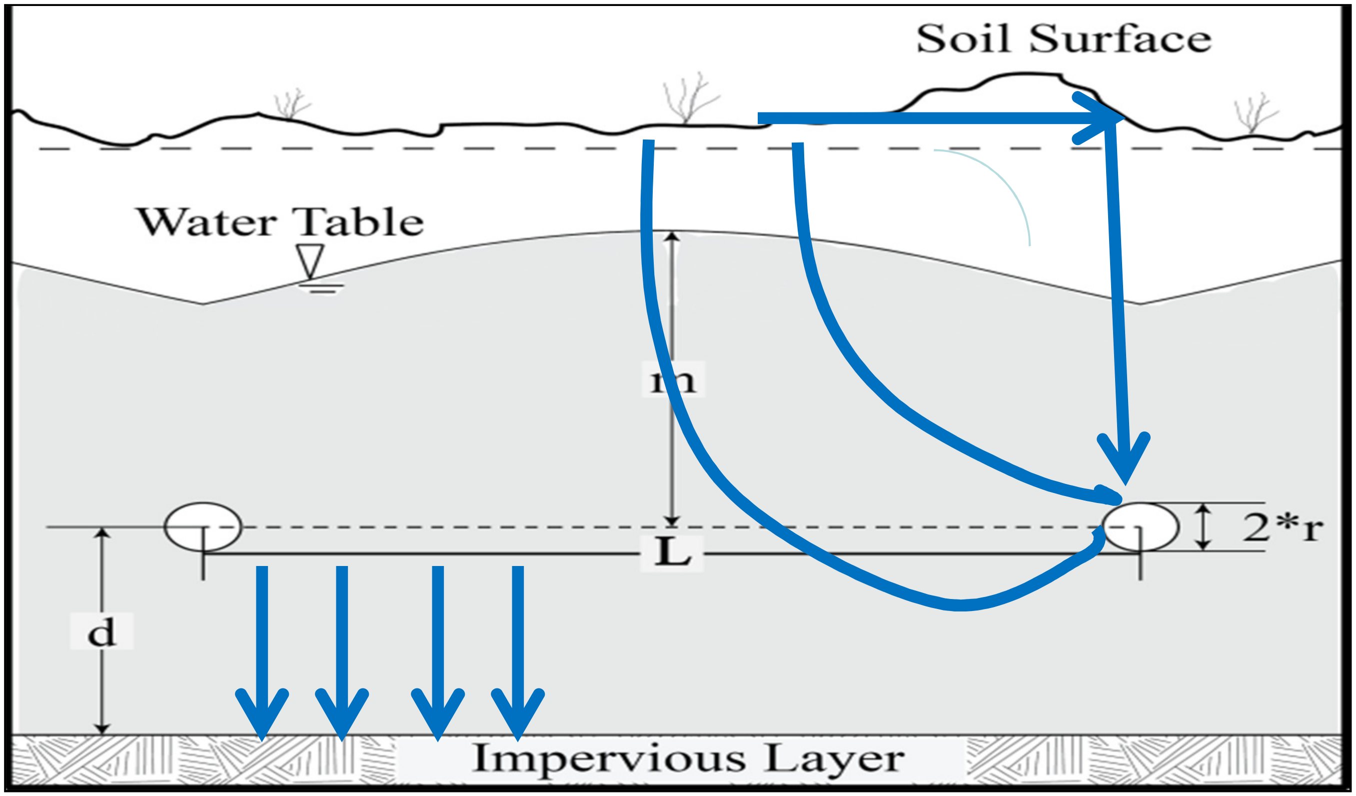
Surface runoff lasts a few hours; **Tile flow** lasts a few days. Both are **hydrograph peaks**



Tile flow is water that has infiltrated; Curve number needs to reflect that.

- SCS Curve number was developed to reproduce the hydrograph
- It is empirical with no physical basis
- Logically, if it is used to separate surface runoff and infiltration, it needs to be greatly reduced in tile-drained landscapes, often by **30%** or more

4. Impermeable layer – depth but especially permeability



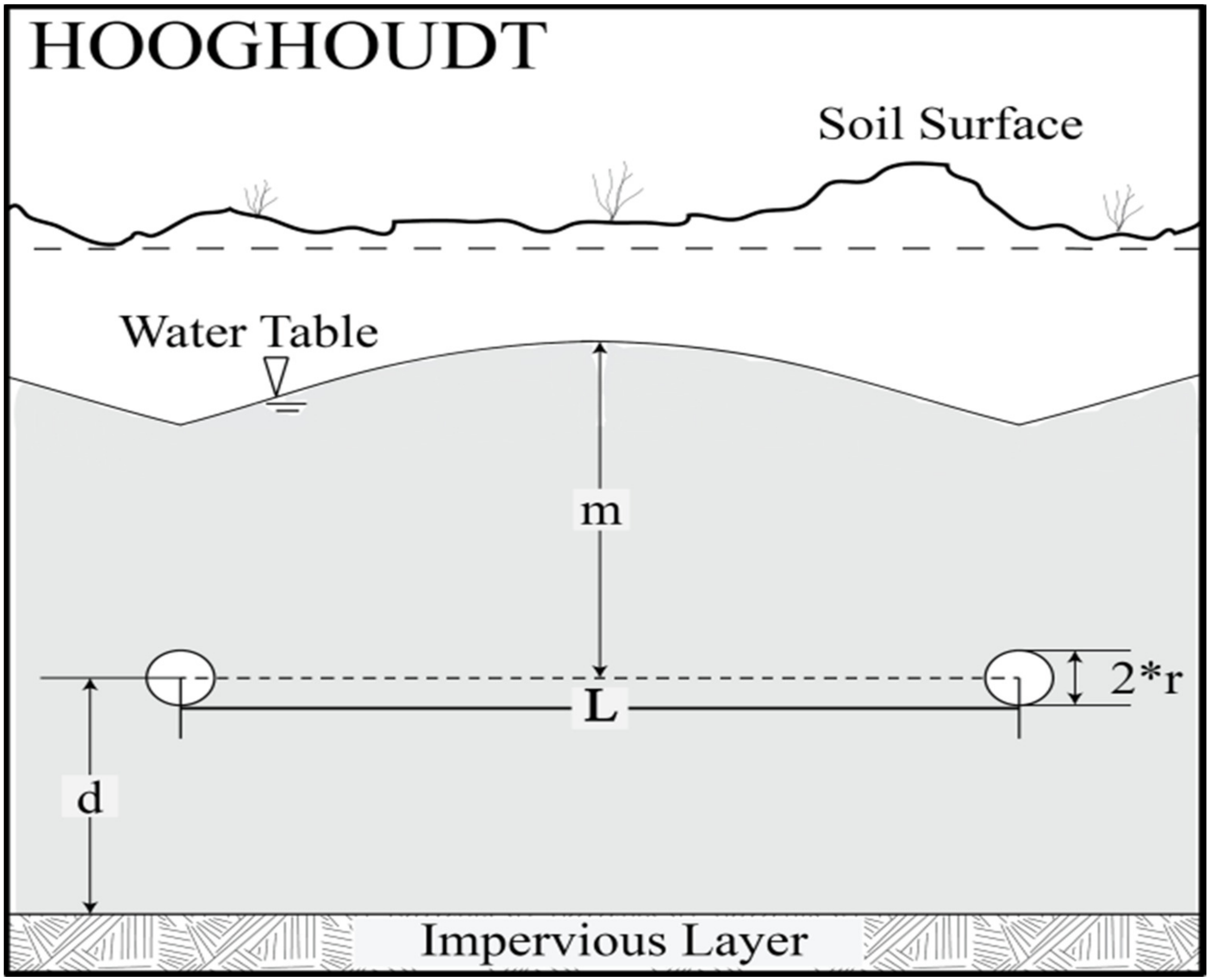
SWAT tile drainage routines

- Older version (since at least SWAT2005) based on drawdown time
  - Defined TDRAIN as the time to drain soils to field capacity, set by the user as a static parameter.
  - GDRAIN, a lag coefficient
  - Large storm or small, the time of drainage is the same.

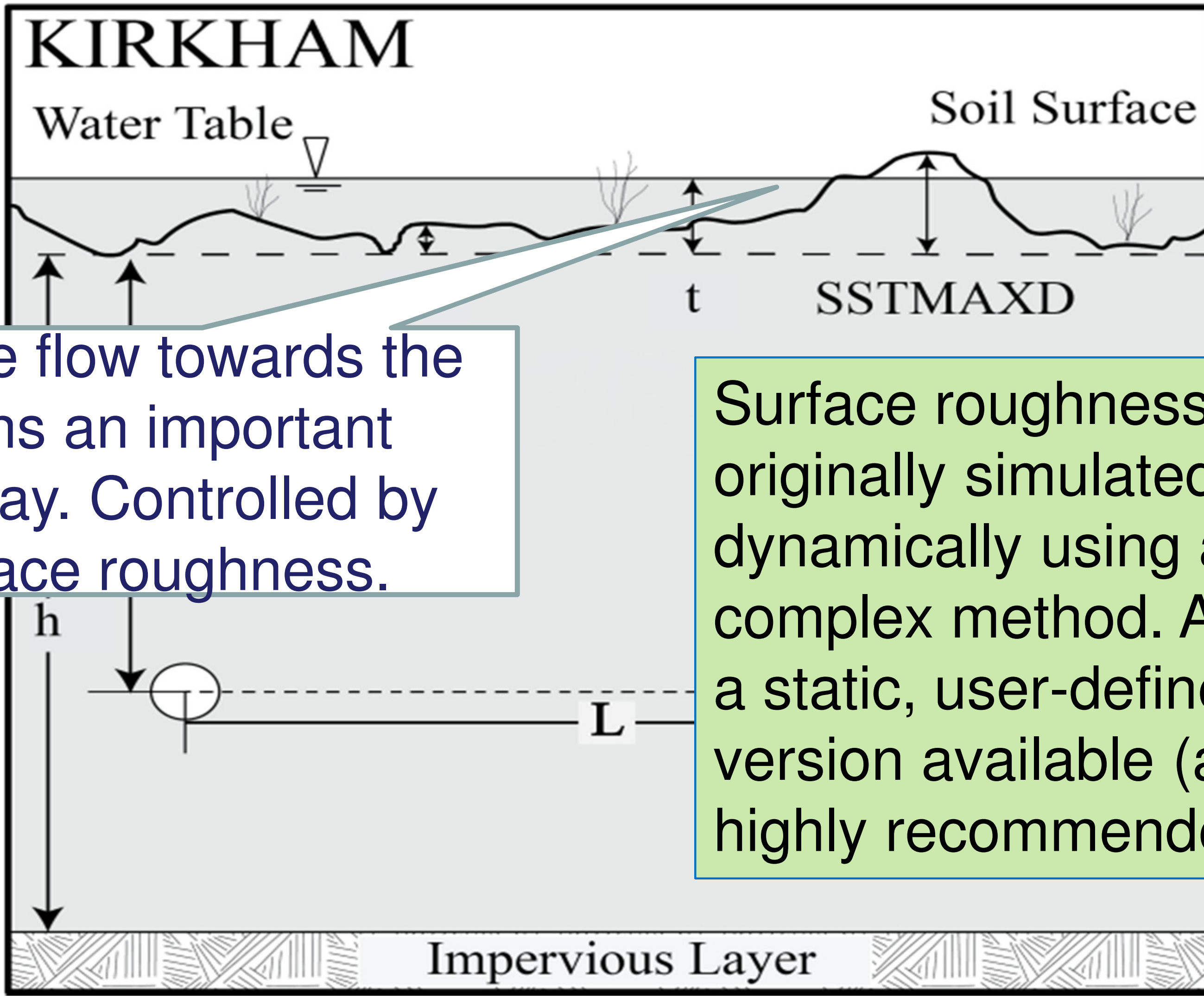
SWAT tile drainage routines

- Moriasi et al. (2007a) developed a new drainage simulation method using the Houghoudt and Kirkham drainage equations and a drainage coefficient
  - Some call this the "DRAINMOD routines"
  - I think H-K-DC would be a good term

Hooghoudt - when water table below the surface (no surface flow)



Kirkham – when water table above the surface

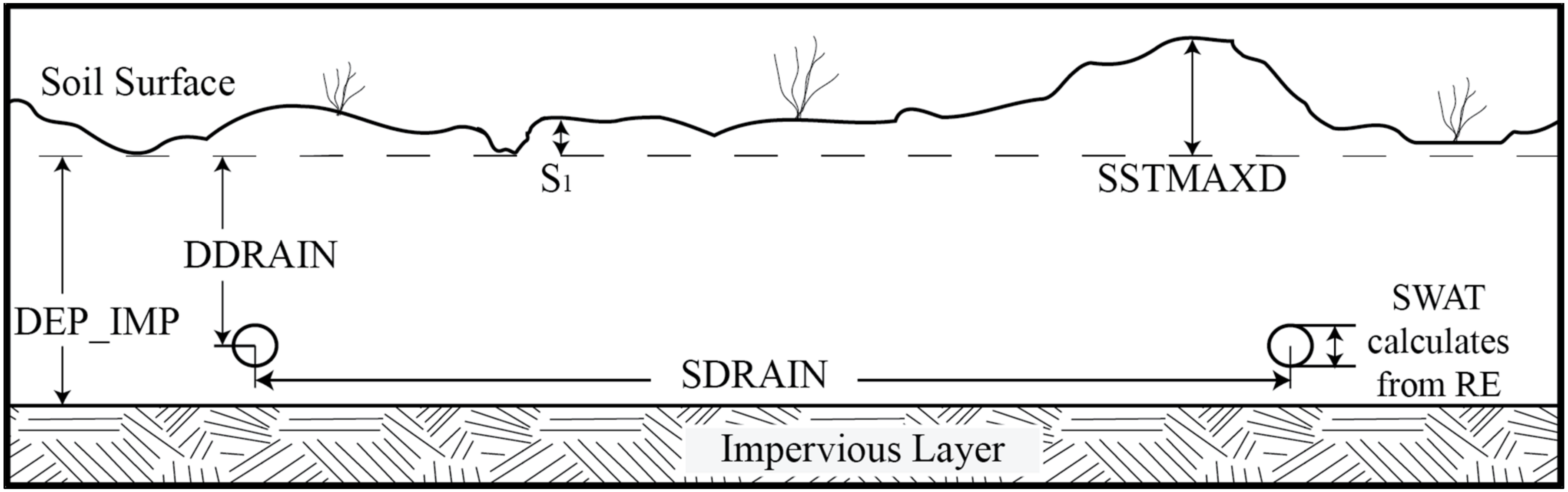


Surface flow towards the drains an important pathway. Controlled by surface roughness.

Surface roughness was originally simulated dynamically using a VERY complex method. After 537 a static, user-defined version available (and highly recommended).

Drainage coefficient – recognizes that pipes can convey a limited amount of water

Photo: Dan jaynes



Drainage parameters in the .sdr file

15.00 | **re:** effective radius of drains (mm)

20000.00 | **sdrain**: distance between two drain tiles (mm)

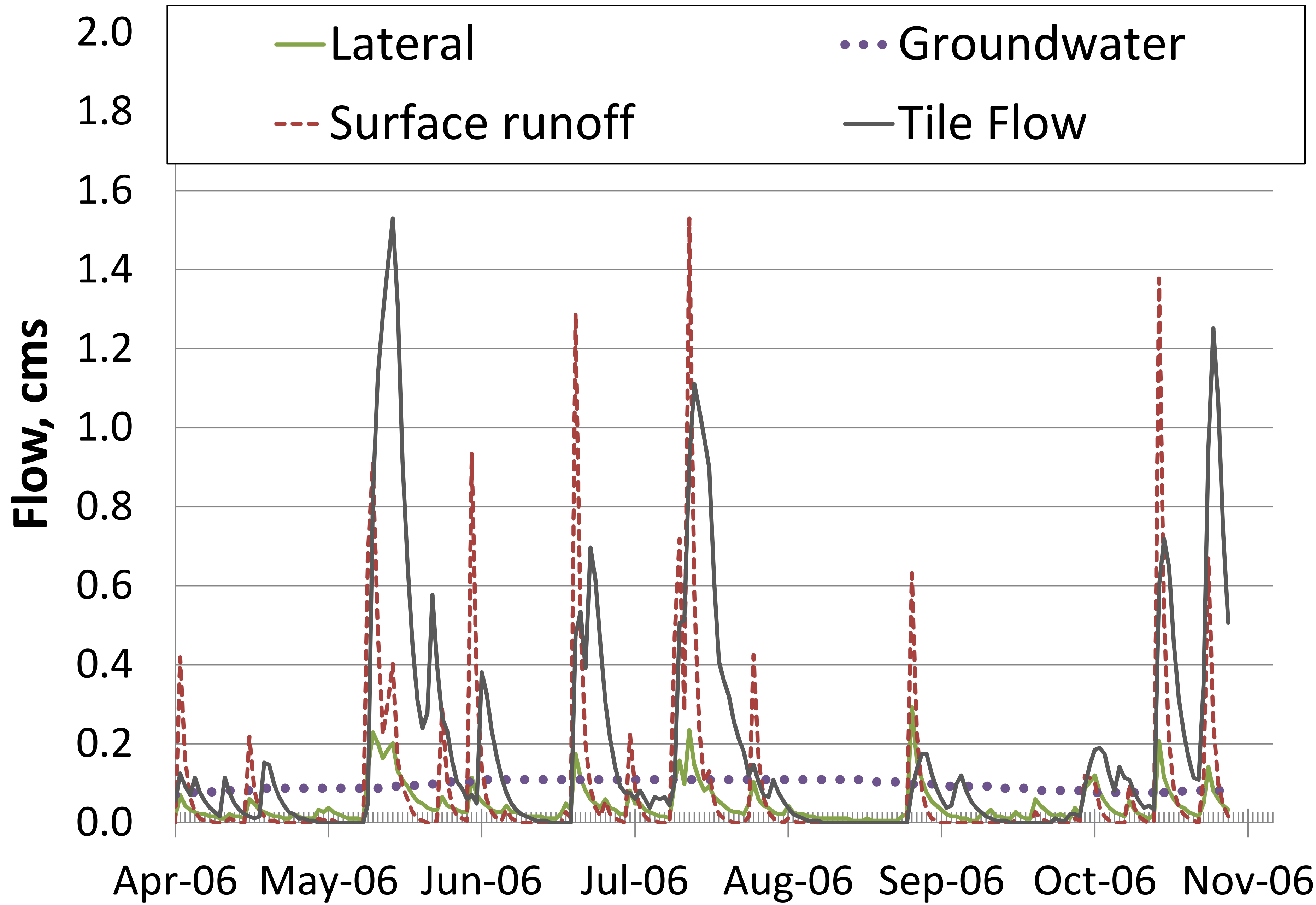
10.00 | **drain_co**: drainage coefficient (mm/day)

0.00 | **pc:** pump capacity (mm/hr)

1.00 | **latksatf:** multi factor for later conductivity

12.50 | **sstmaxd**: Static maximum depressional storage (mm)

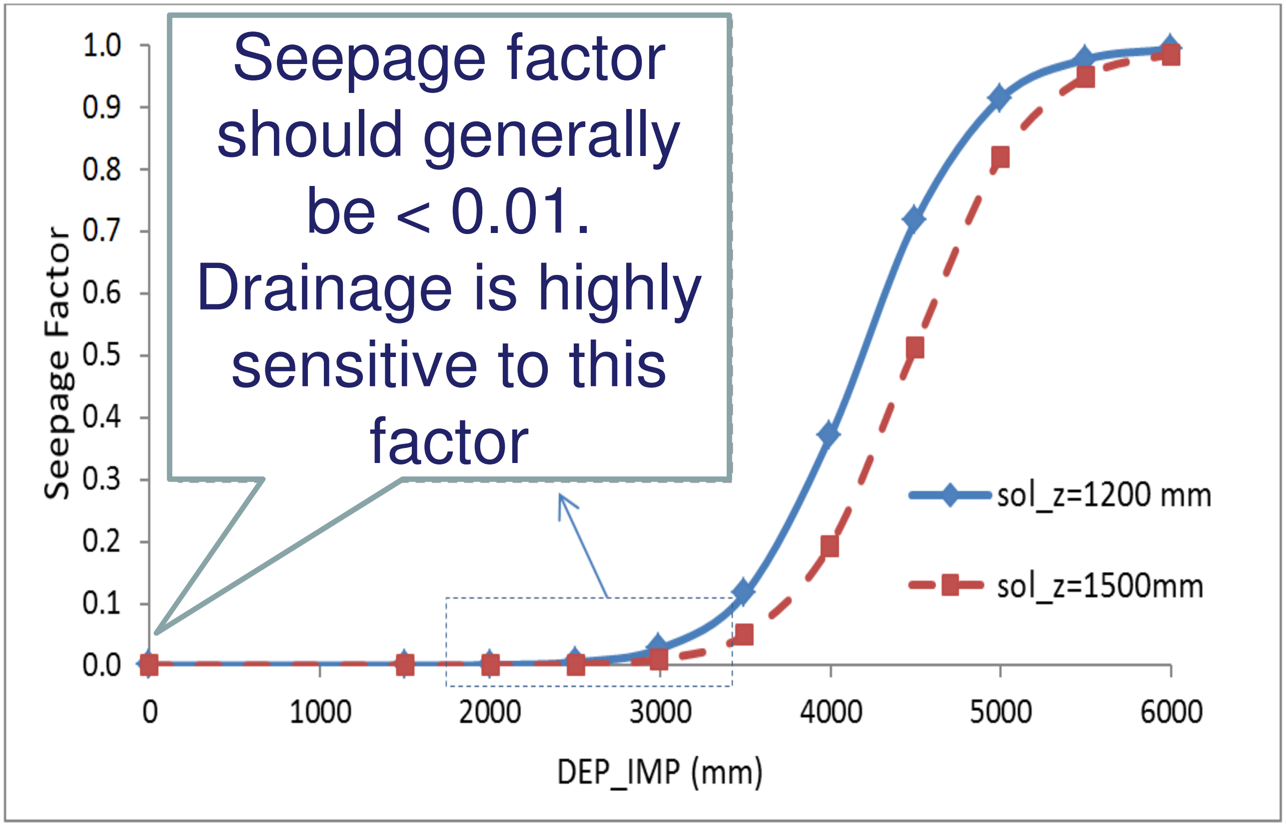
Resulting partition of flow pathways



Remaining Needs

The impermeable layer – Depth and permeability need to be separated

- "DEP_IMP" described as a depth, but actually controls permeability (seepage through the layer)



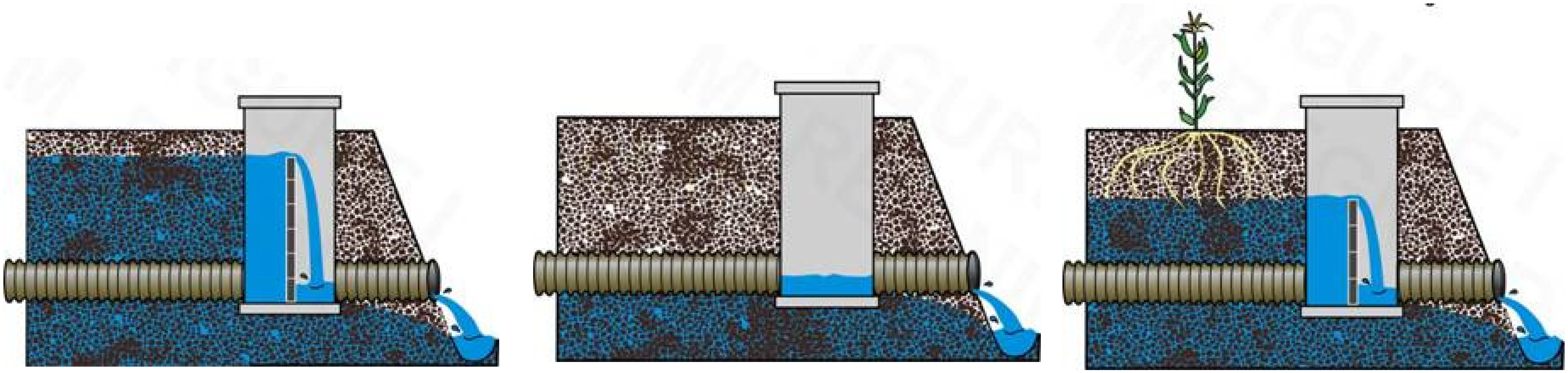
Simulating phosphorus in tile drains

- Need to simulate through macropores

Drainage water management

- Control structures placed in main drain lines
- Gives the potential to control the height of the drain outlet.

Drainage water management



Drainage needed is not the same throughout the year.

- **In winter,** drainage is not needed.
- **In spring,** maximum drainage is needed to get into the field
- Holding back water in **the summer** can help the crop

Cumulative Impacts of BMP Implementation in the Upper Maumee Watershed

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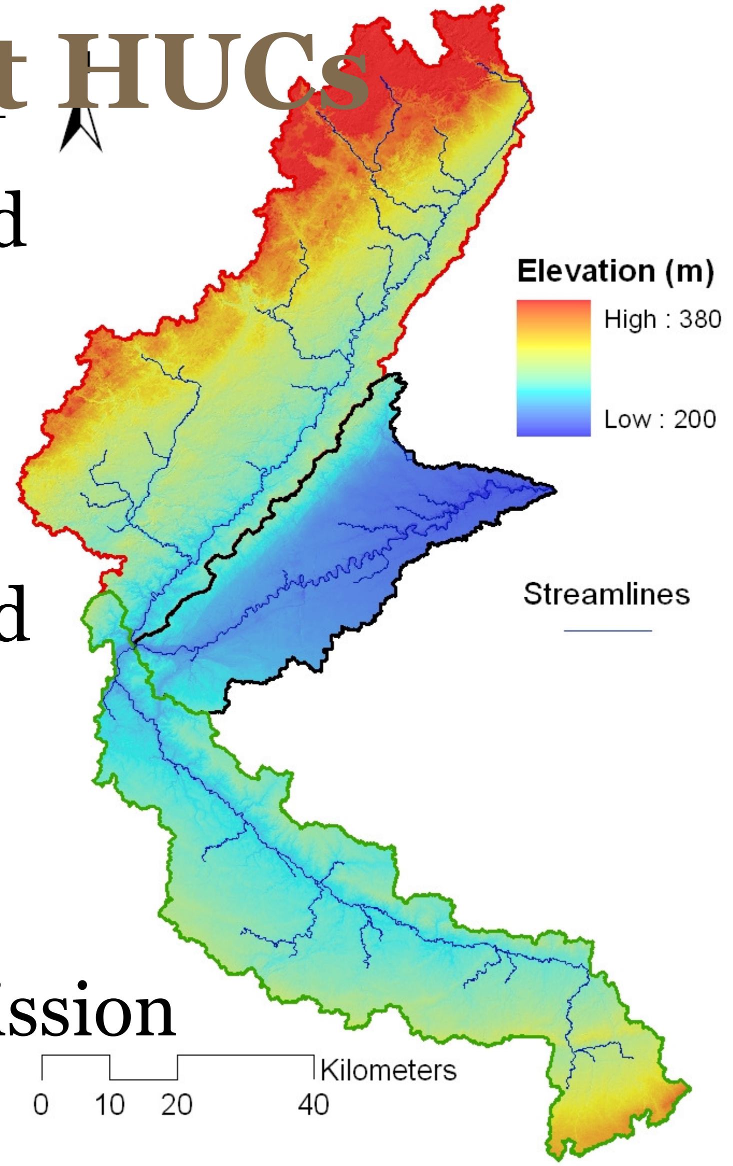
Overall Project Goal

Watershed modeling to inform watershed management

1. Estimate potential water quality improvements due to the installation of conservation practices.
2. Work with watershed groups to use and benefit from modeling results in their watershed management plans

Working with partners in three 8-digit HUCs

- **St. Joseph** River Watershed Initiative
- **St. Marys** River Watershed Project
- **Upper Maumee** Watershed Project
- Allen County Soil and Water Conservation District
- Maumee River Basin Commission
- USDA – NRCS



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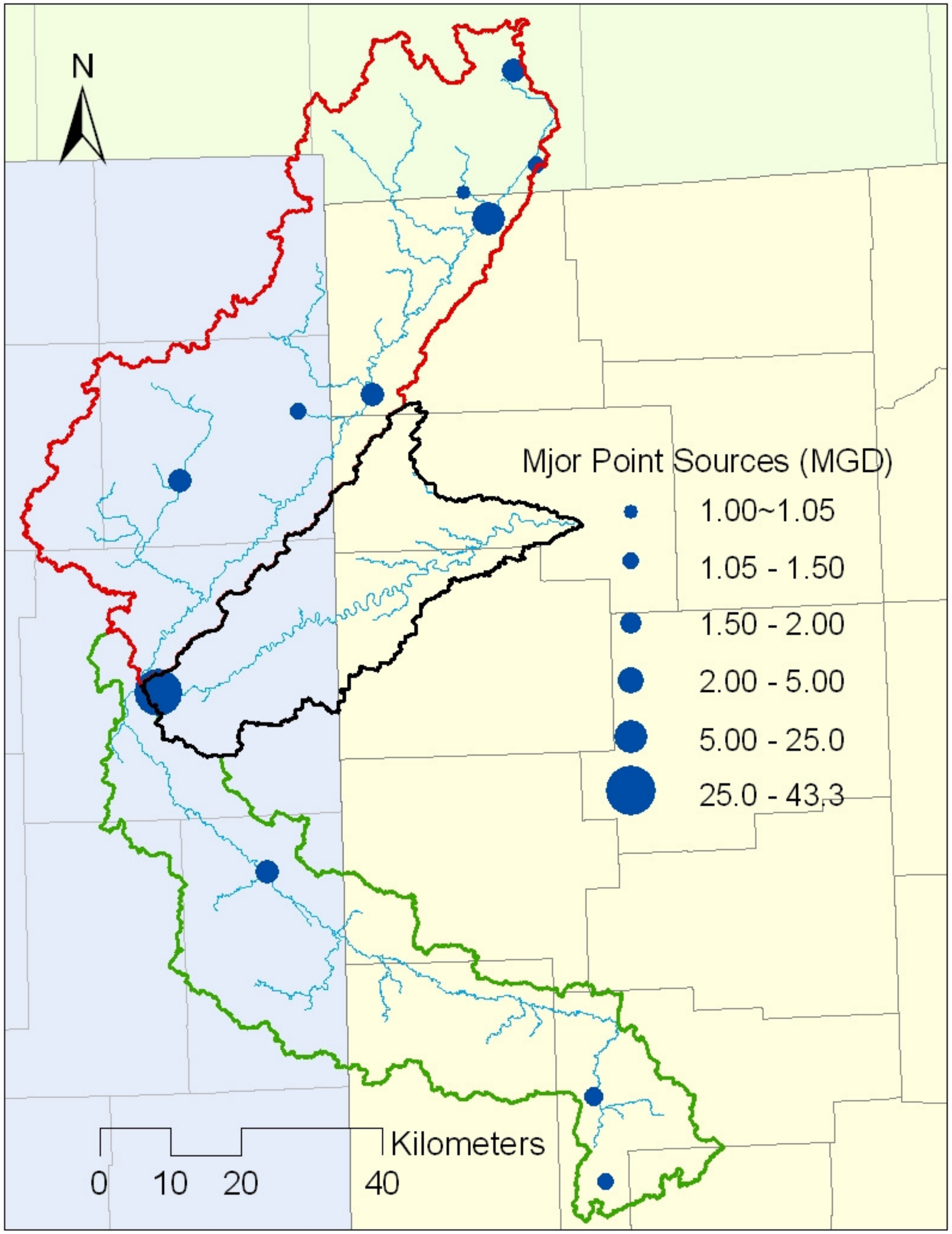
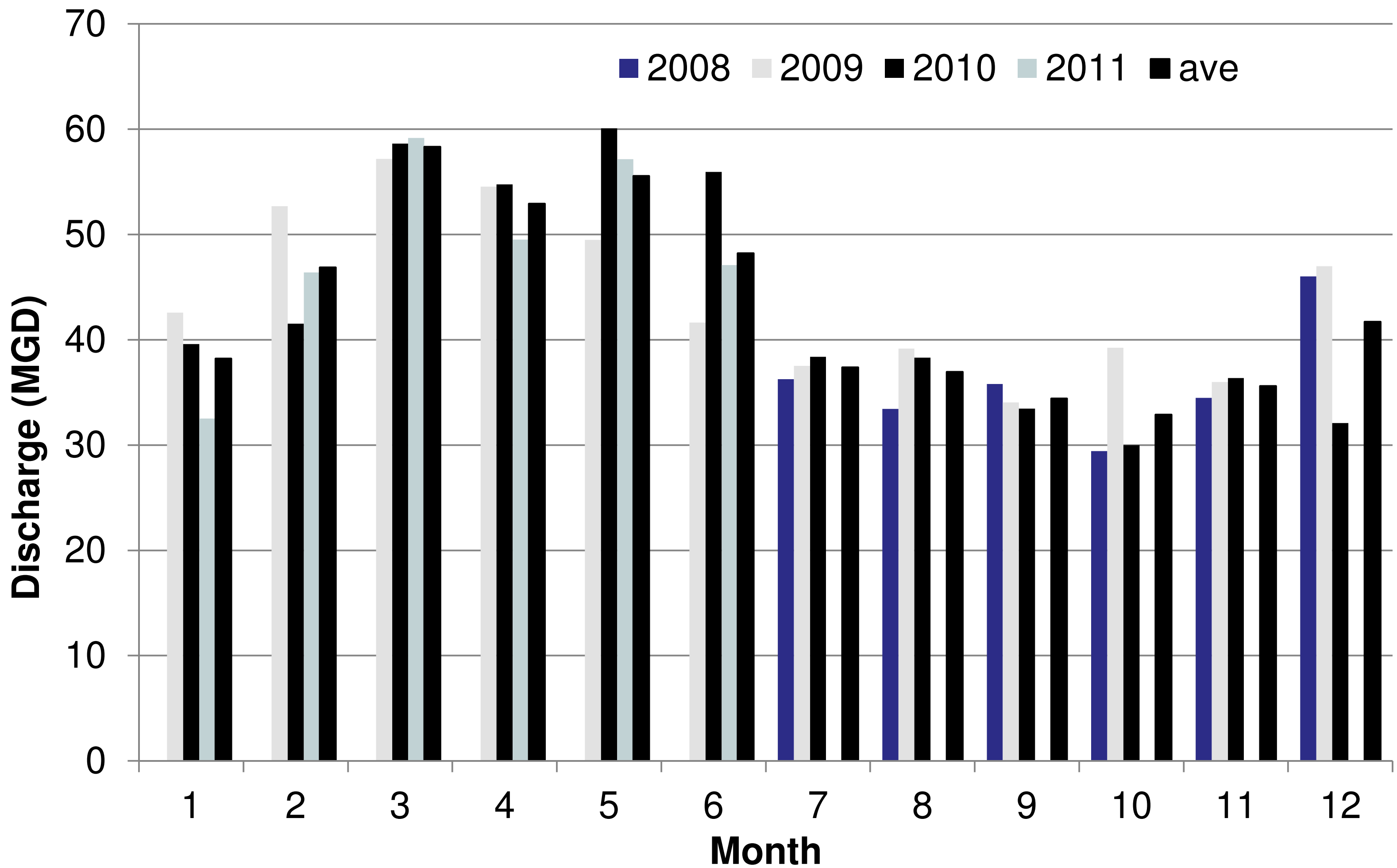
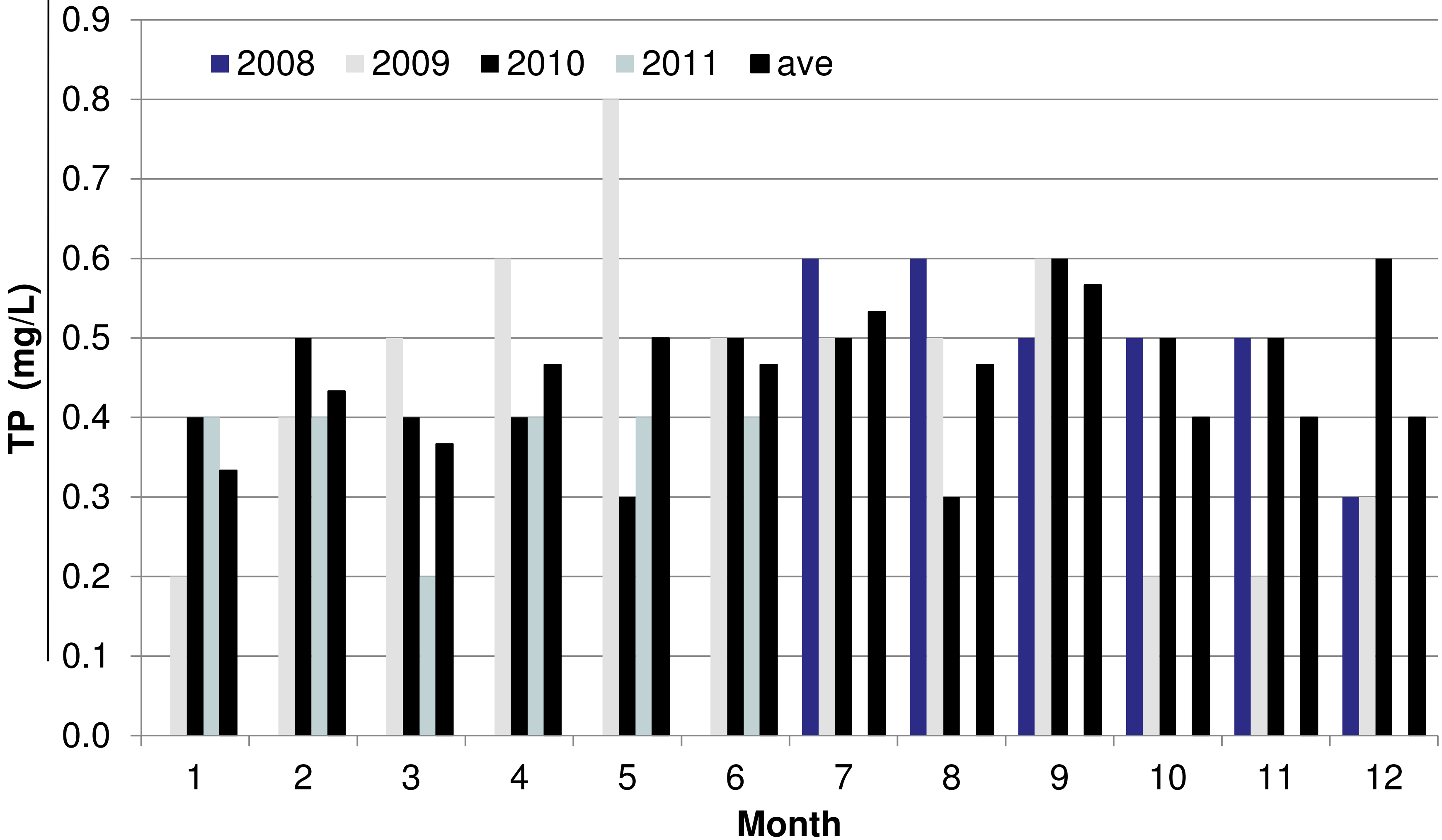
- **Input data:** Point Sources (Wastewater Treatment Plants)



EPA-ECHO point source – Discharge by month



EPA-ECHO point source – Phosphorus by month

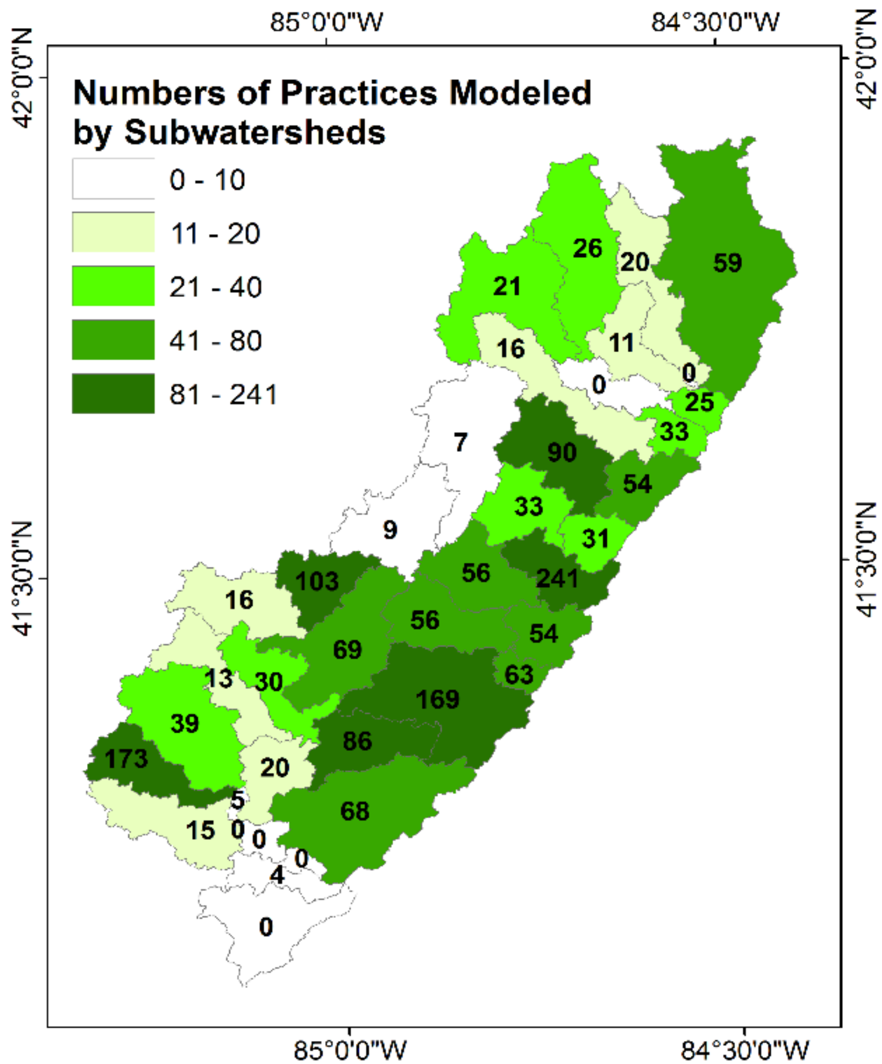


Effect of conservation practices if implemented on all appropriate land

BMPs	Load Reduction (%)				
	Sediment	Dissolved P	Total P	Nitrate N	Total N
Cover crops	26 - 68	5 - 17	14 - 49	16 - 31	31 - 43
Filter strips	36 - 40	30 - 32	32 - 36	5 - 6	19 - 22
No-till	13 - 19	-14 - 19	1 - 8	-7 - 1	0 - 7
WASCOBs	13 - 43	4 - 10	7 - 47	-3 - -1	3 - 16

Practices actually implemented in the St. Joseph Watershed

- Through an MOU with NRCS we were able to receive practice information (with D. Smith, ARS)
- Information on **10,028** conservation practices
- Identified those likely to have a water quality effect that can be simulated.



Practice	Number of Fields	Area (ac)
Conservation Crop Rotation (328*)	1,418	40,538
No Till (329 + 329A+SOE01)	1,408	40,409
Nutrient Management (590+ENM)	1,105	35,487
Conservation Cover (327)	541	7,348
Cover Crop (340+WQL10+SQL02)	232	6,717
Filter Strip (393)	309	4,760
Biomass Planting (512)	133	1,750
Field Border (386)	88	1,730
Split N application (WQL07)	49	1,362
Mulch Till (329B+345)	50	1,148
WASCOB (638)	10	756
Total	5,583	148,104

Nutrient and sediment reductions are different between field and watershed scales.

Conservation Practices	Acres Treated in Watershed (acre)	Water Quality Parameter	Field Scale (Load reduction in areas applied) (%)	Watershed Scale (as % of total watershed loading) (%)
Conservation Cover (327) (High effectiveness but little implementation)	2,372	TN	81.9%	0.2%
		TP	99.4%	0.3%
		Sediment	99.1%	0.3%
No Till (329+329A) (Low effectiveness for nutrients, but much implementation)	19,781	TN	5.2%	0.5%
		TP	10.5%	1.2%
		Sediment	17.4%	1.4%

Conclusion: The tile drain routines in SWAT allow us to more accurately simulate processes and practice effects; Remaining needs include:

1. Separating impermeable layer depth and permeability

2. Phosphorus flow through macropores (and outputs of tile drain phosphorus)

Looking forward to the discussions!