

# URBAN NON-POINT SOURCE IMPACTS ON SEATTLE AREA STREAM PHOSPHORUS TRANSPORT

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How much does phosphorus transport differ in Seattle area urban and forest streams?



**SCALES:** Long term (decadal), seasonal (monthly), inter-annual (daily), and event based (hourly).

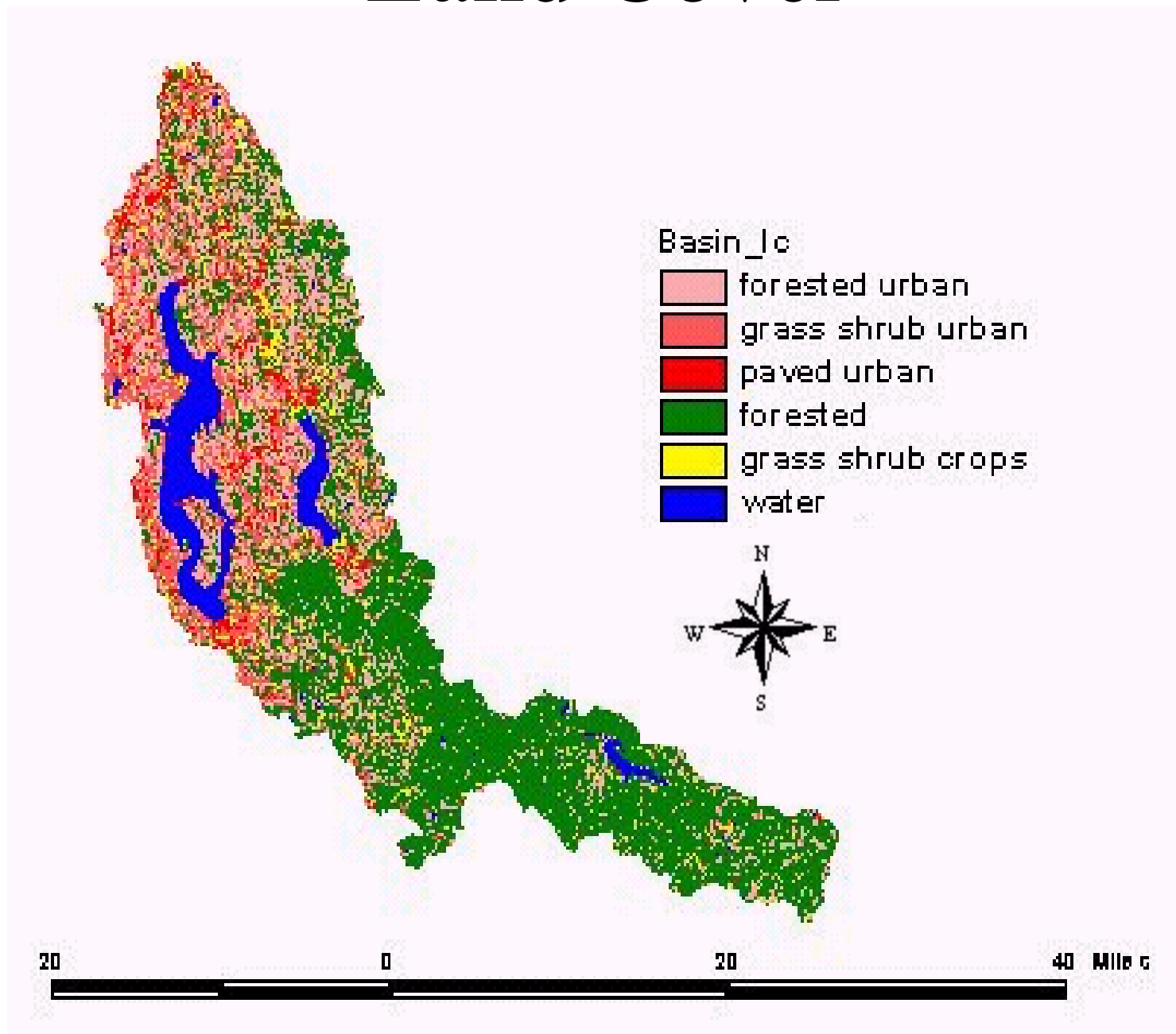
An aerial photograph of a rowing athlete in a white boat on a green lake. The water is covered in a thick layer of green algae, with several dark, irregular patches scattered across the surface. The athlete is positioned at the bottom of the frame, moving away from the viewer. The text 'Lake Washington in the Past (and the Future?)' is overlaid in red on the upper left portion of the image.

Lake Washington in the Past  
(and the Future?)

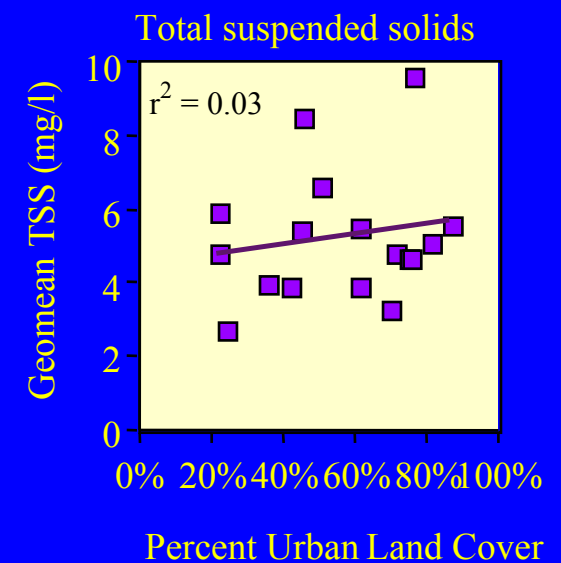
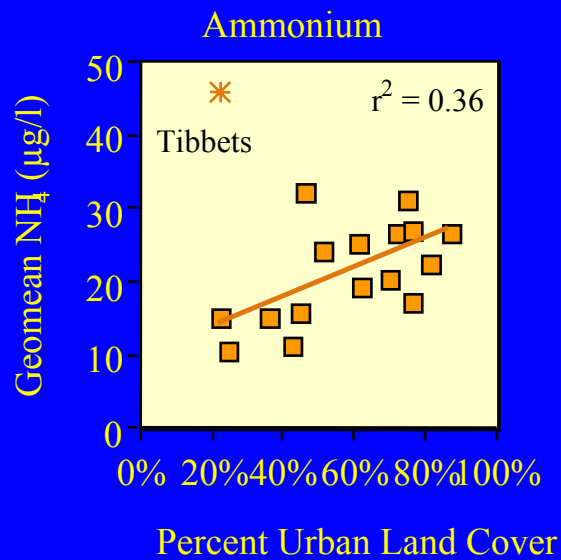
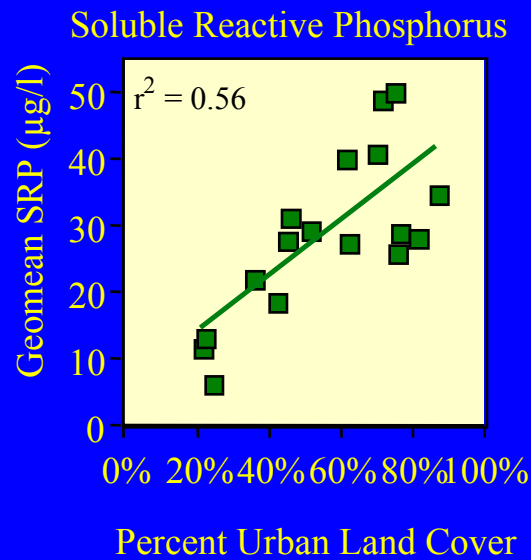
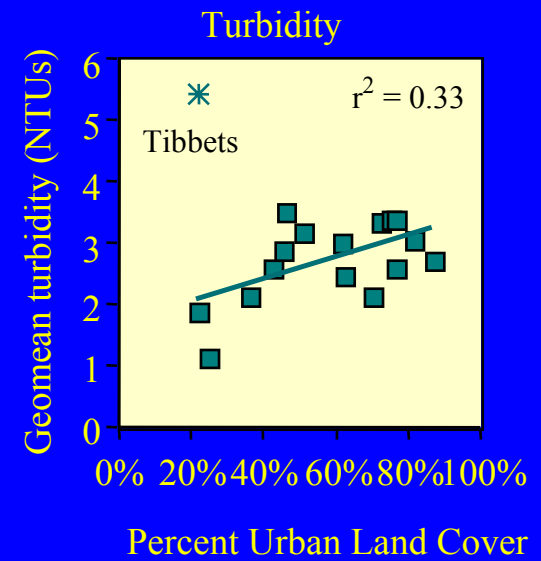
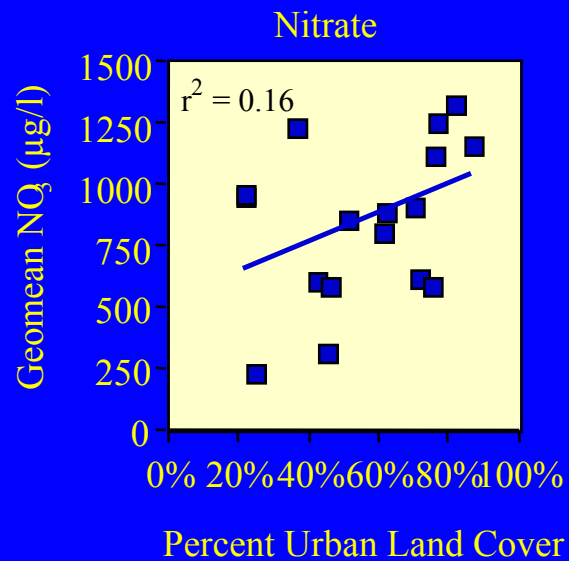
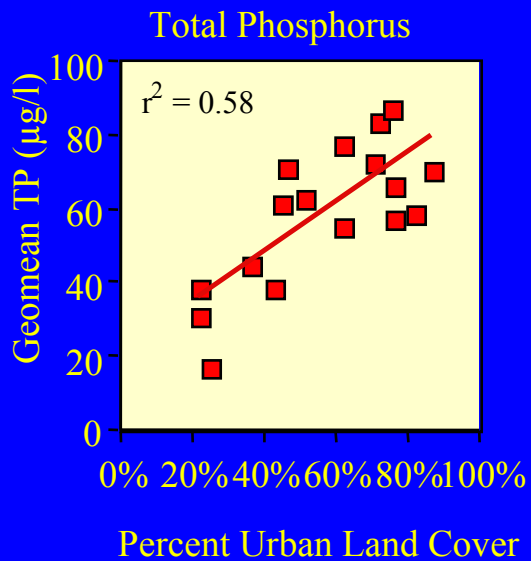
Eutrophication  
&  
Surface WQ

© World Watch Magazine

# Land Cover

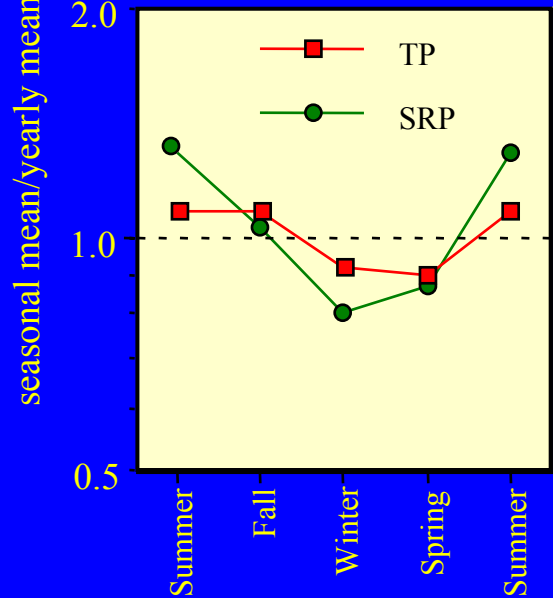


# Land Cover Versus Stream Nutrients: Normal Flows

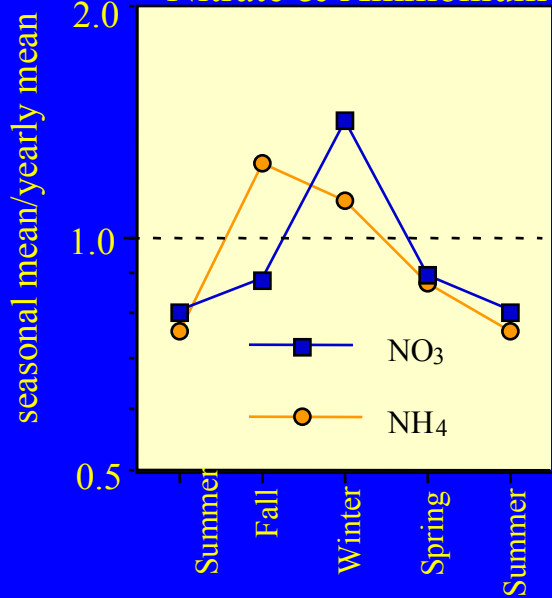


# Seasonal Fluctuations in Stream Constituent Concentrations

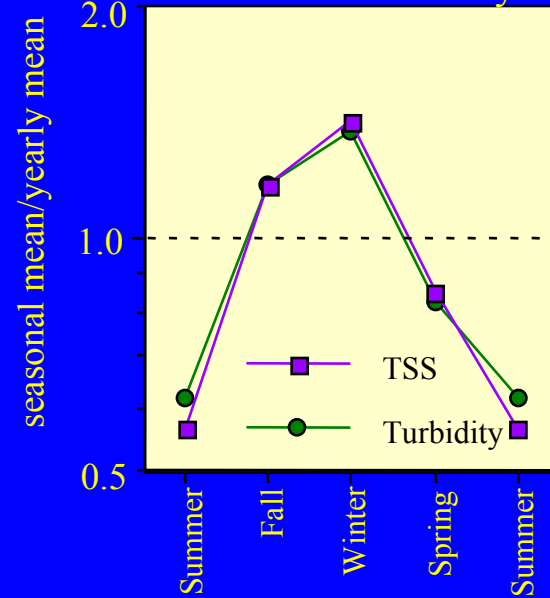
Total & Soluble Reactive Phosphorus



Nitrate & Ammonium



TSS and Turbidity



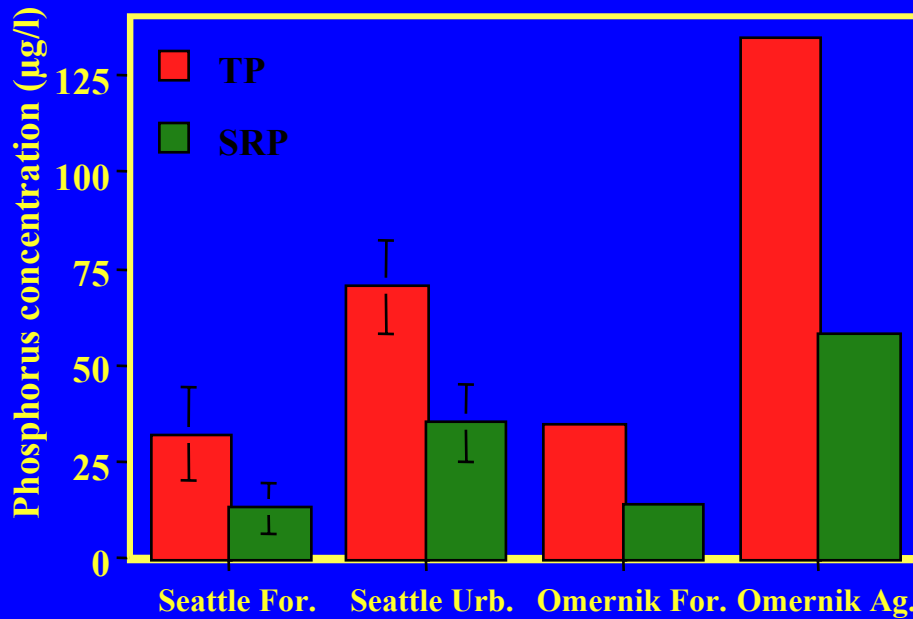
SRP:DIN ratio

Summer  
Winter

48  
133

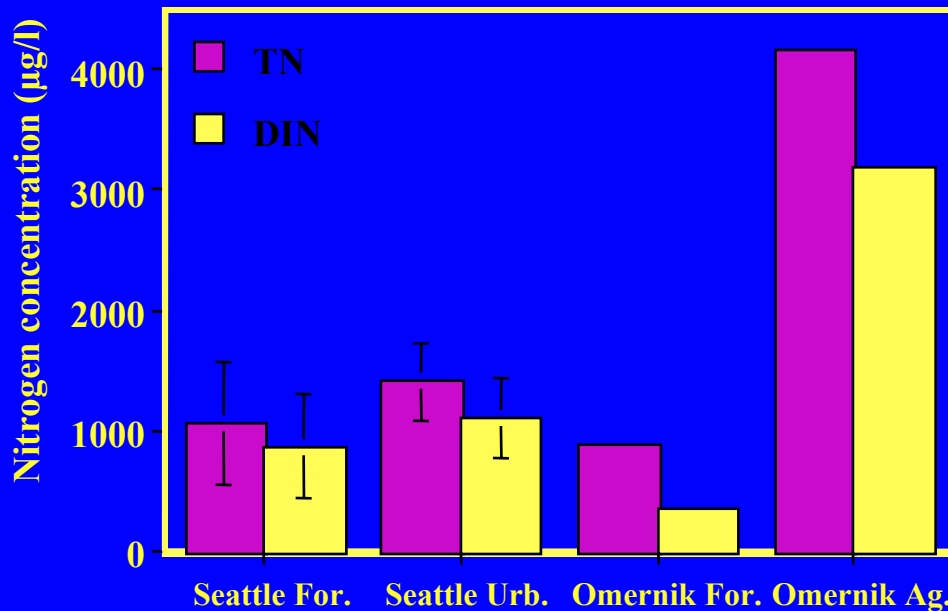
## Percent Urban Enrichment

Constituent	Units	Average Forested	Average Urban	Percent Enrichment
Total Phosphorus	µg/l	32.3	67.8	109%
Soluble Reactive P	µg/l	13.1	33.4	154%
Total Nitrogen	µg/l	1065	1412	33%
Nitrate	µg/l	840	1088	29%
Ammonium	µg/l	13.7	24.8	81%
Turbidity	NTUs	1.71	3.01	77%
Total Susp. Solids	mg/l	4.33	5.90	36%



Seattle forest streams have 150% more DIN than typical forest streams

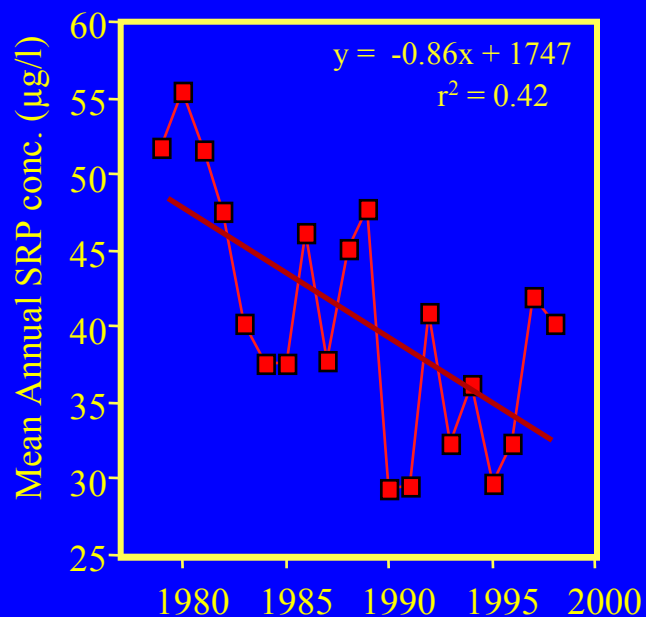
Seattle urban streams have about 50% as much phosphorus as typical agricultural streams



Seattle urban streams have about 35% as much nitrogen as typical agricultural streams

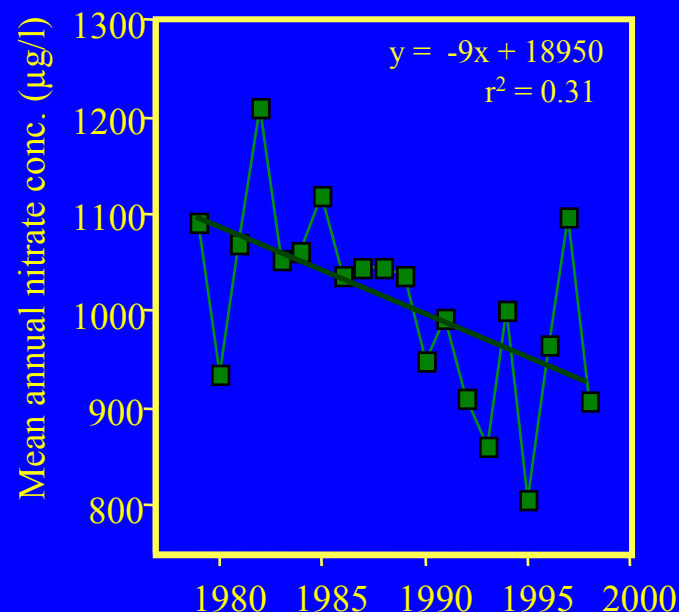
## Averaged Change in SRP Concentrations for the most urban Seattle area streams (Thornton, Juanita, McAleer, Lyon, Forbes, Kelsey)

Urban stream SRP concentrations



36% decline in SRP

Urban stream nitrate concentrations

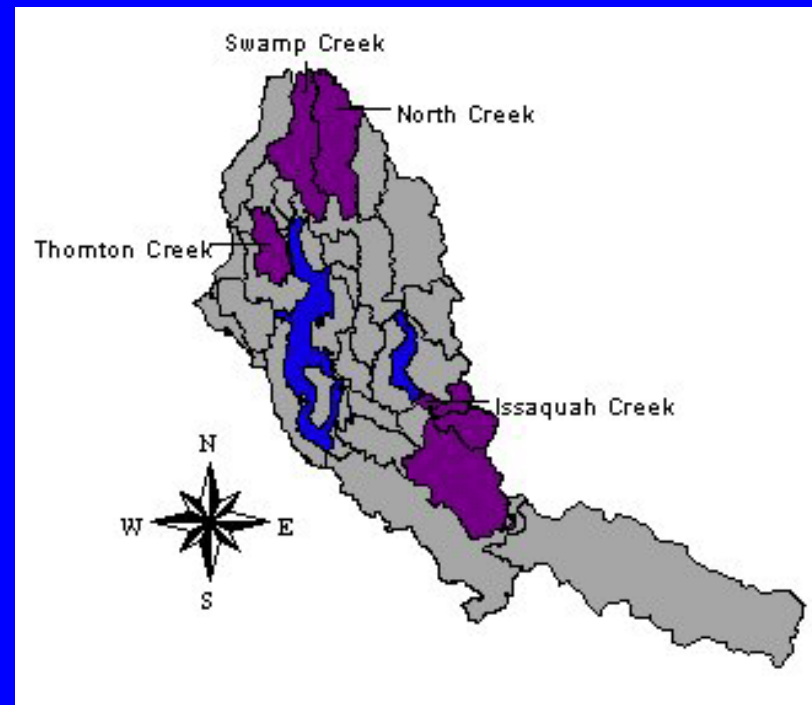


15% decline in  $\text{NO}_3$

**WHY: BMPs, human behavior, catchment surface disturbance?**

# An Annual Time Series of Stream Phosphorus Transport

- Issaquah - Forest
  - North - Mixed
  - Swamp - Mixed
  - Thornton - Urban
- 
- Daily TP
  - Weekly SRP
  - Daily TSS



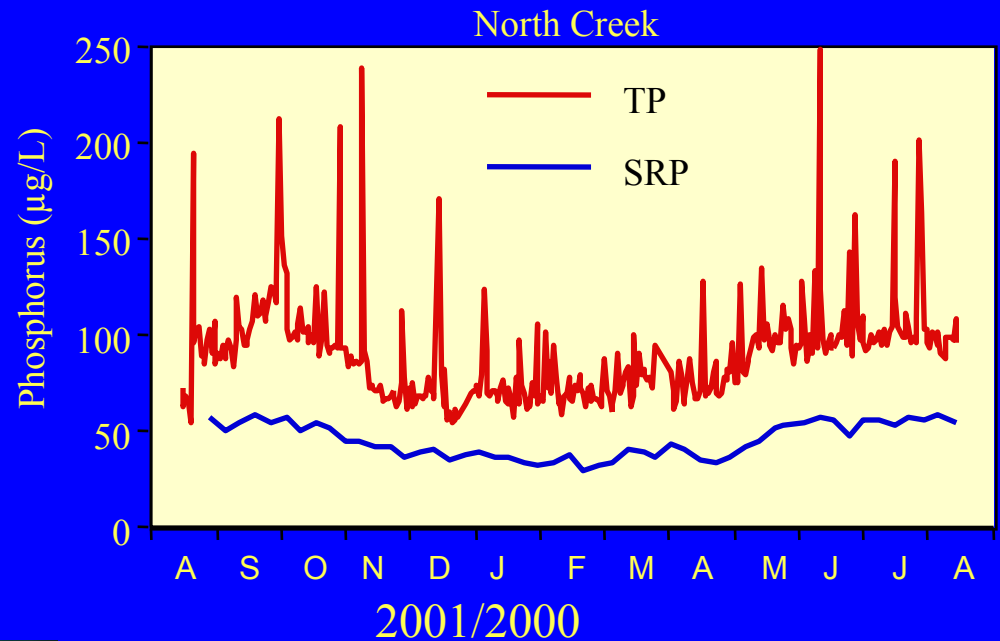
**Objective:** to collect a high resolution stream phosphorus concentration database in order to develop statistical time series models of stream phosphorus transport.



**Model structure:**

- Seasonal term
- Spikeness term
- Antecedent term
- Rainfall term

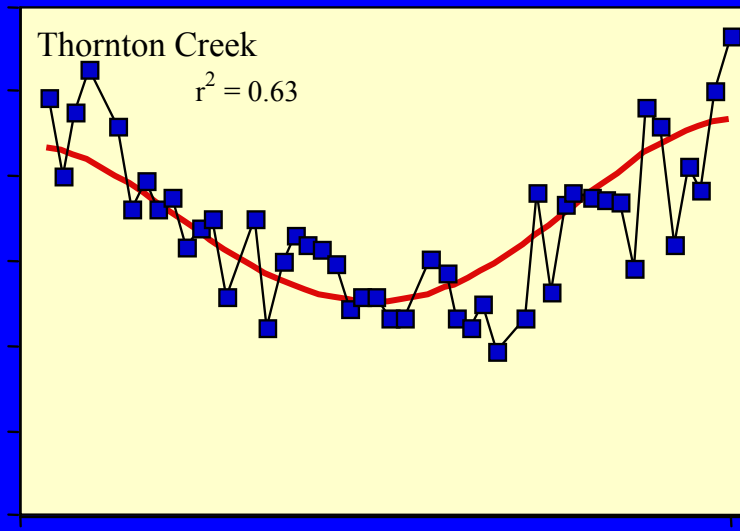
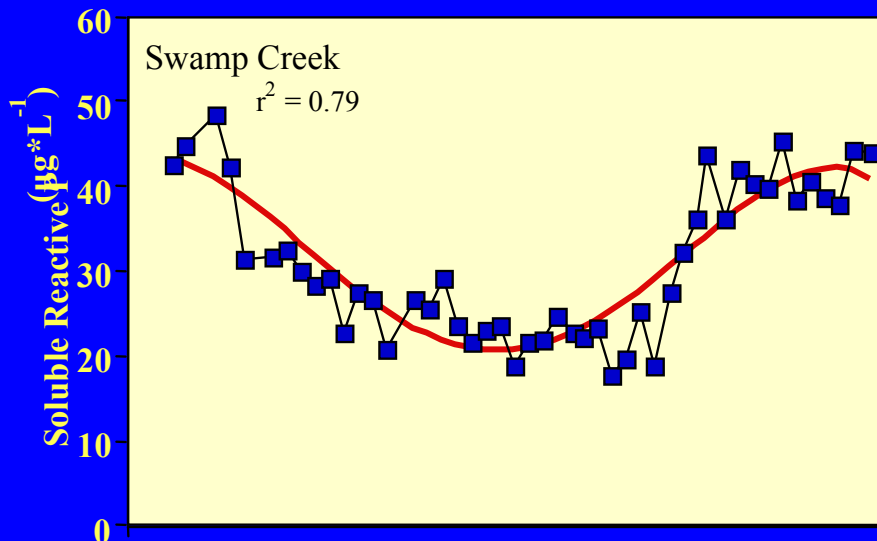
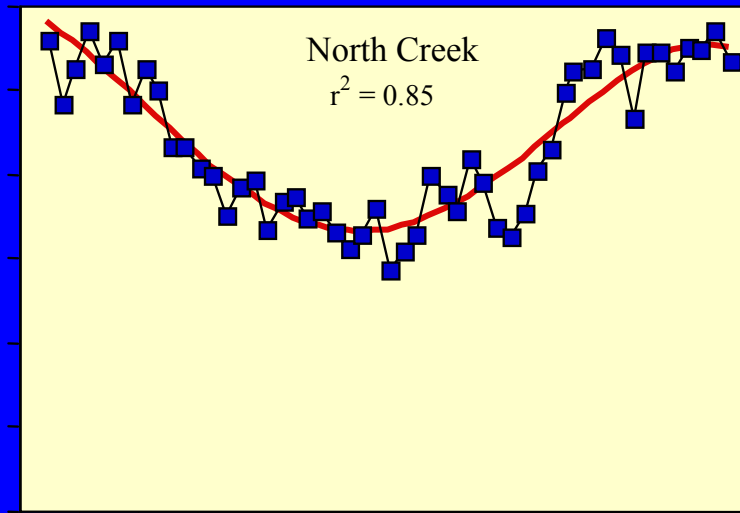
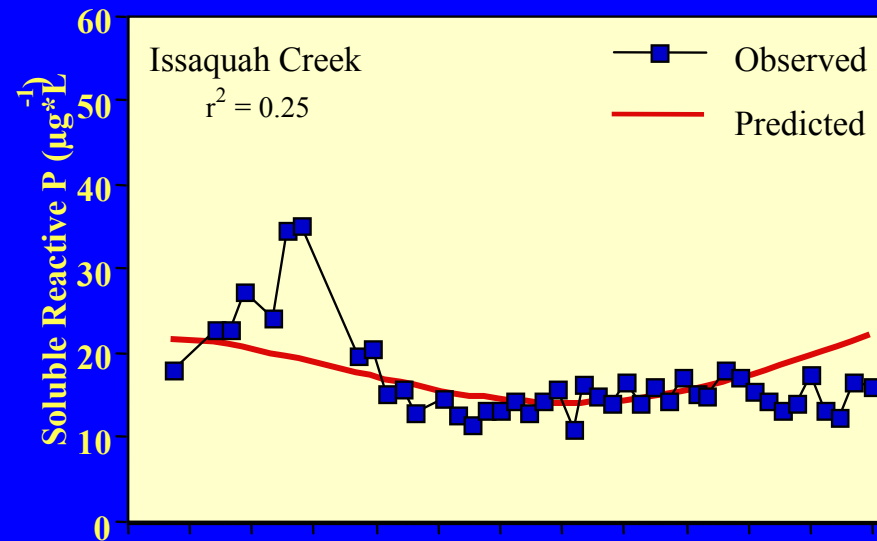
Overall TP varied by  
 $\pm 50\%$  from week to week



SRP varied by  $\pm 20\%$   
from week to week

SRP was on average 48% of TP

# Soluble reactive phosphorus times series



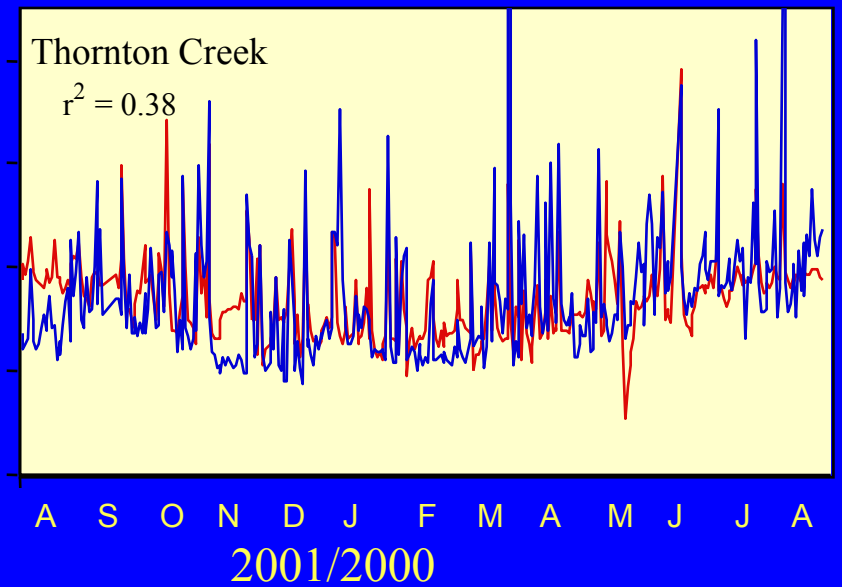
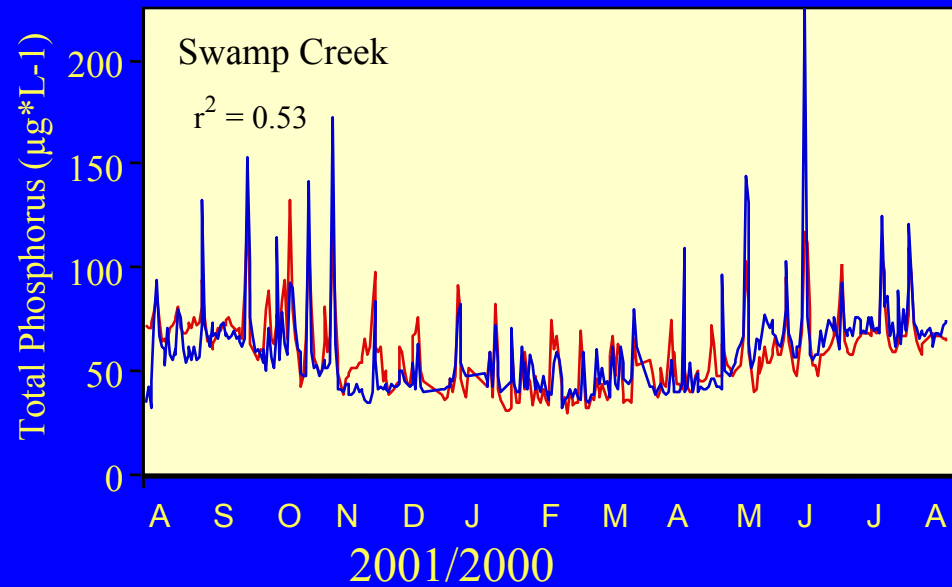
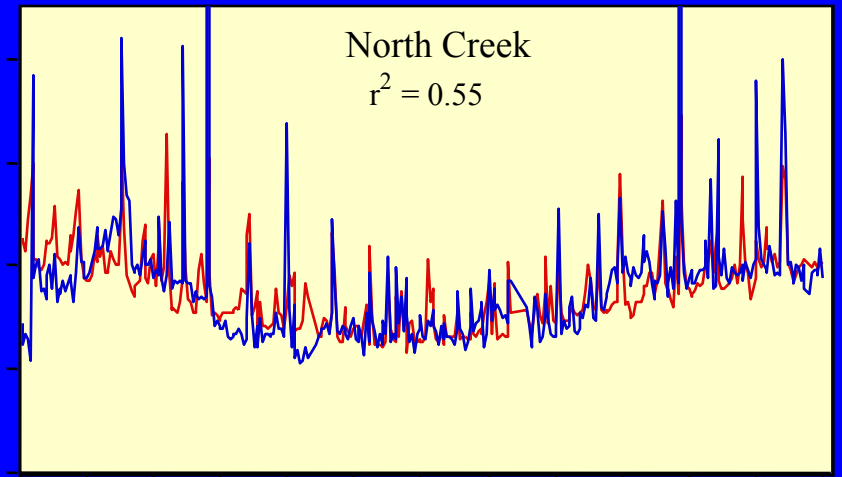
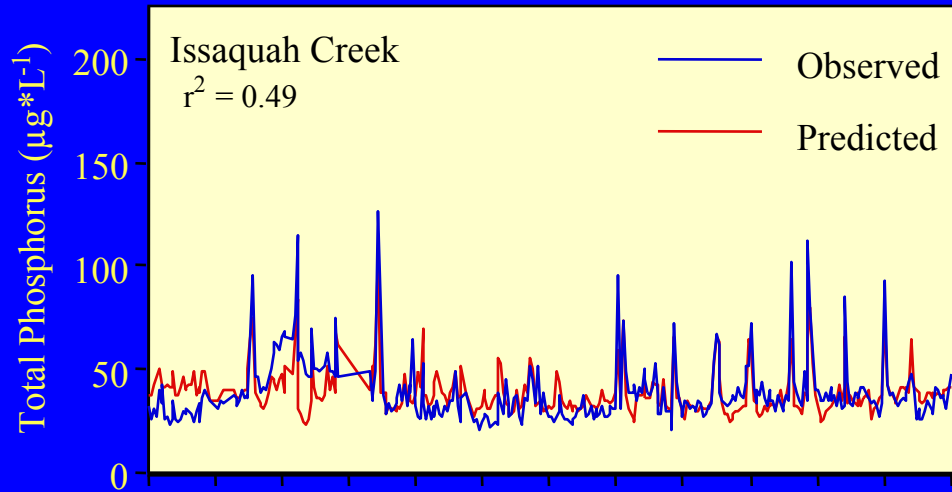
A S O N D J F M A M J J A

2001/2000

A S O N D J F M A M J J A

2001/2000

# Total phosphorus times series



A photograph of a river with large rocks and dense green vegetation in the background. The water is turbulent, creating white foam as it flows over the rocks. The background is filled with lush green trees and bushes.

**Phosphorus transport during  
storm events over a range of land  
use conditions**

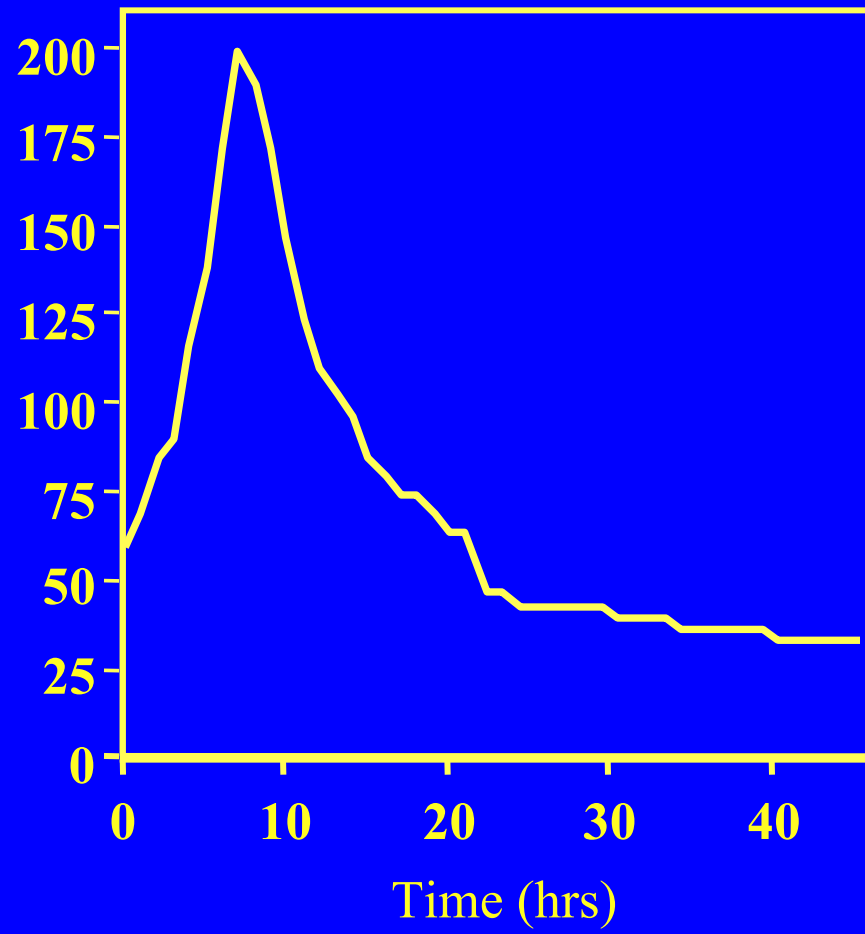
# Study sites

- Four watersheds
  - Agriculture, 392 ha
  - Urban, 123 ha
  - Forested, 497 ha
  - Suburban, 197 ha



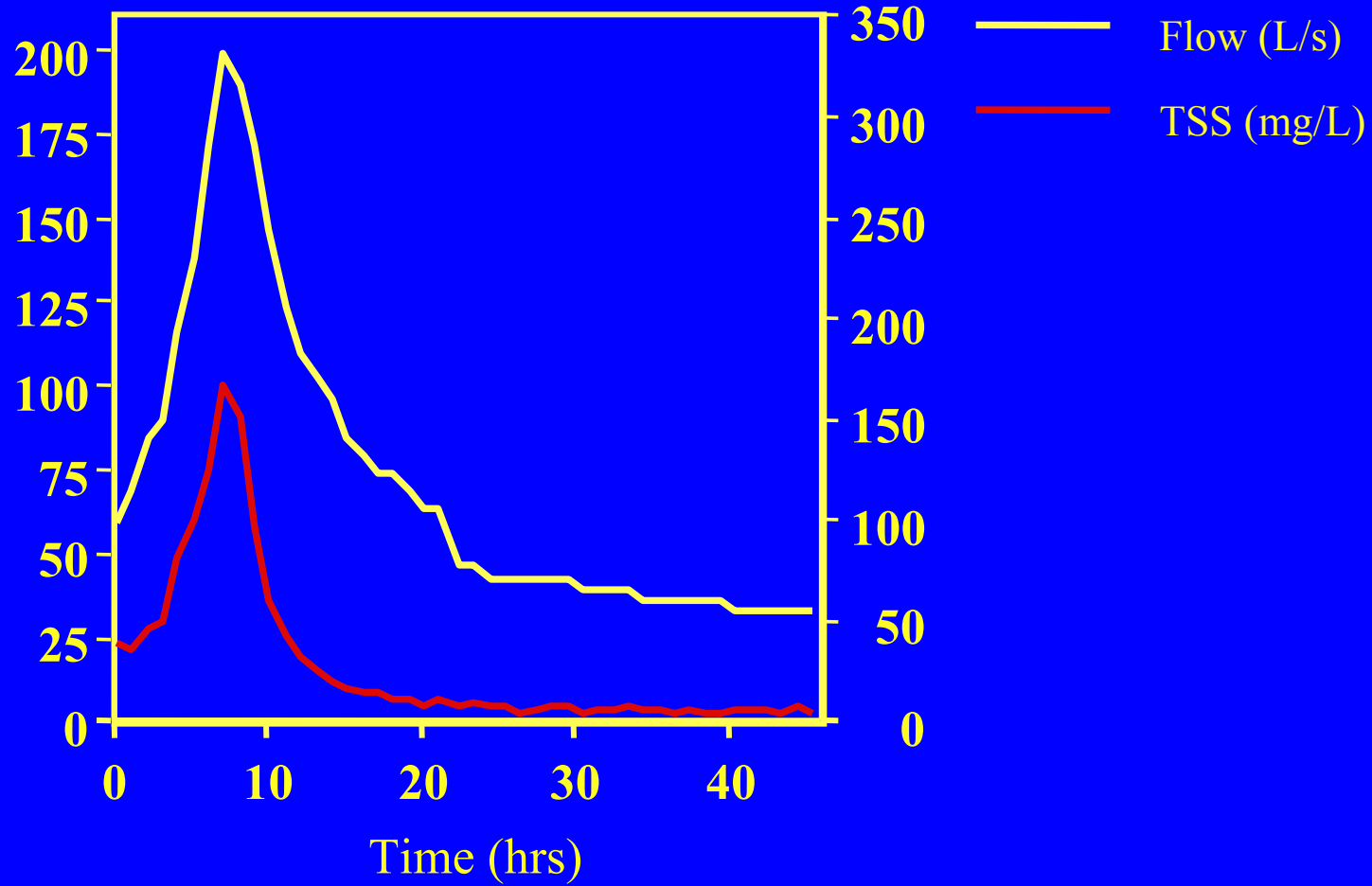
- All sampling sites were within Green-Duwamish River watershed

## Forested Stream

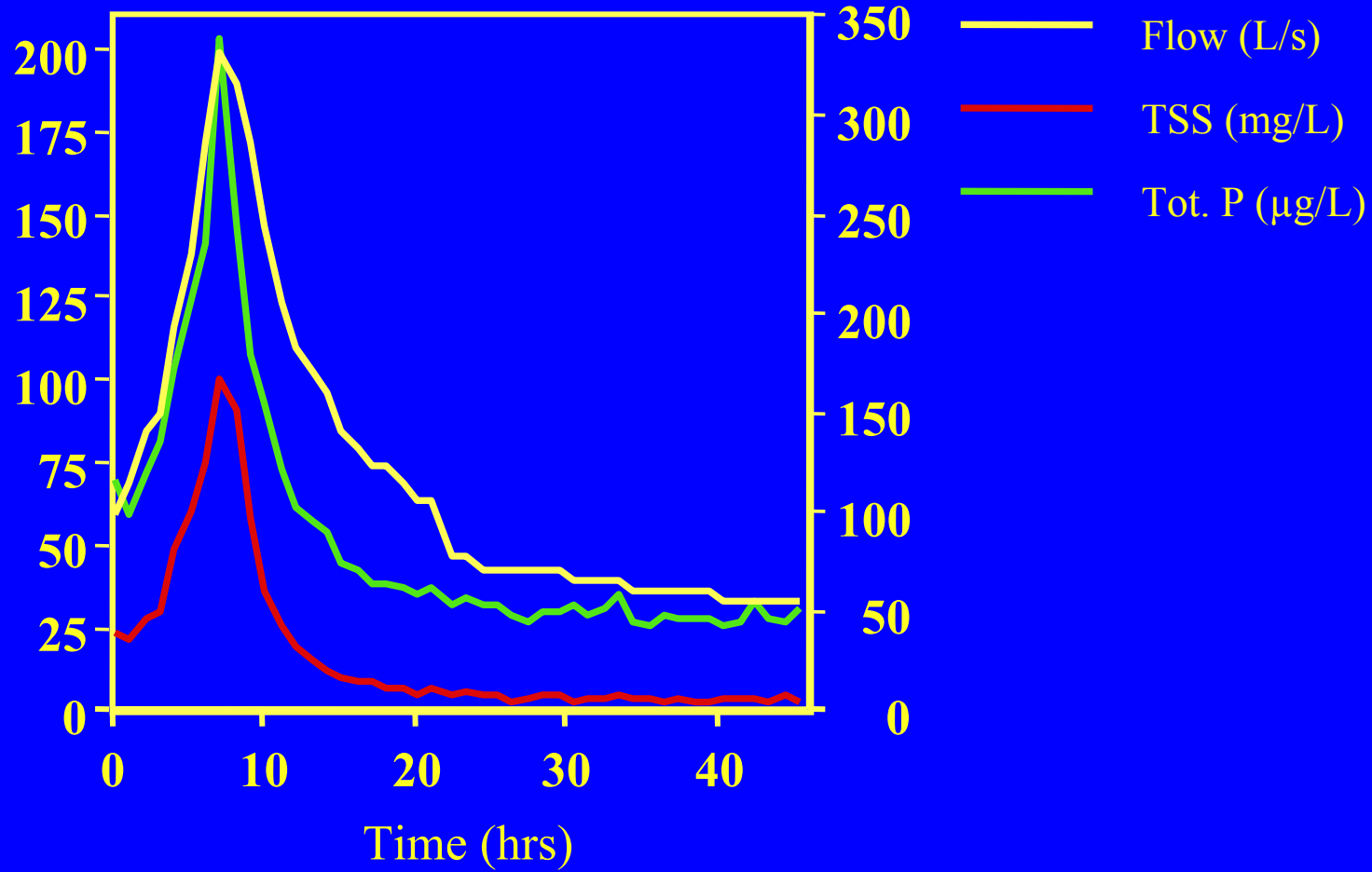


— Flow (L/s)

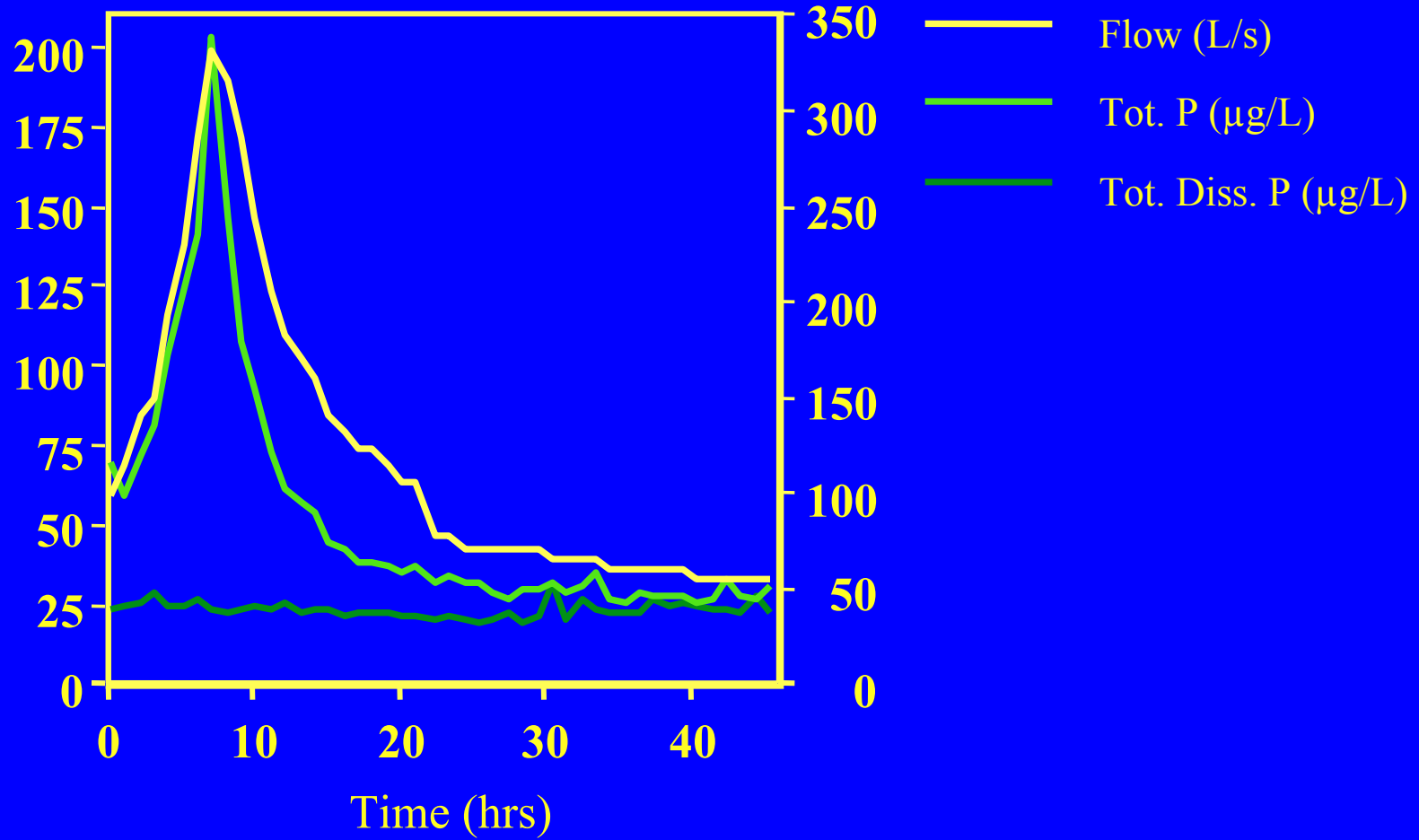
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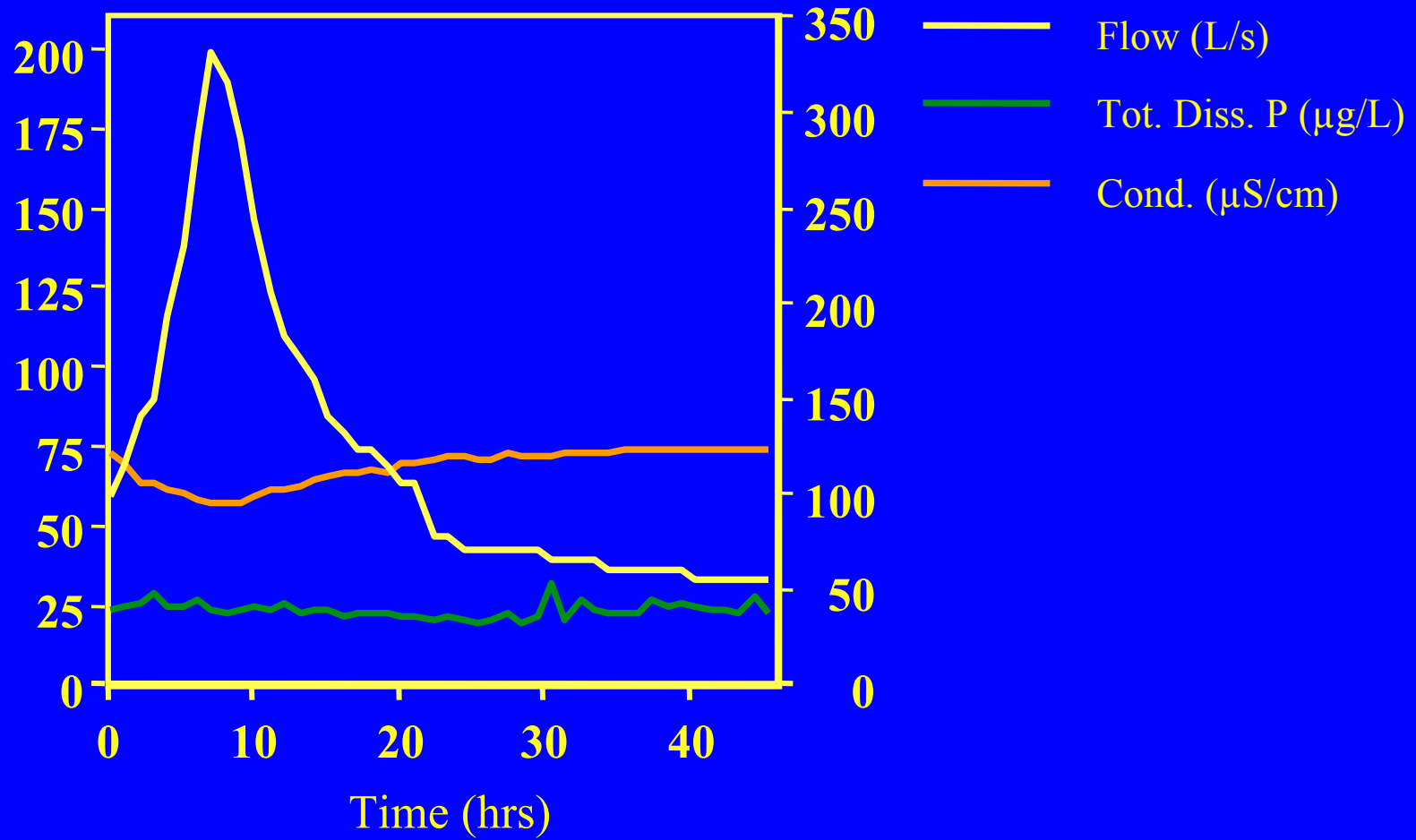
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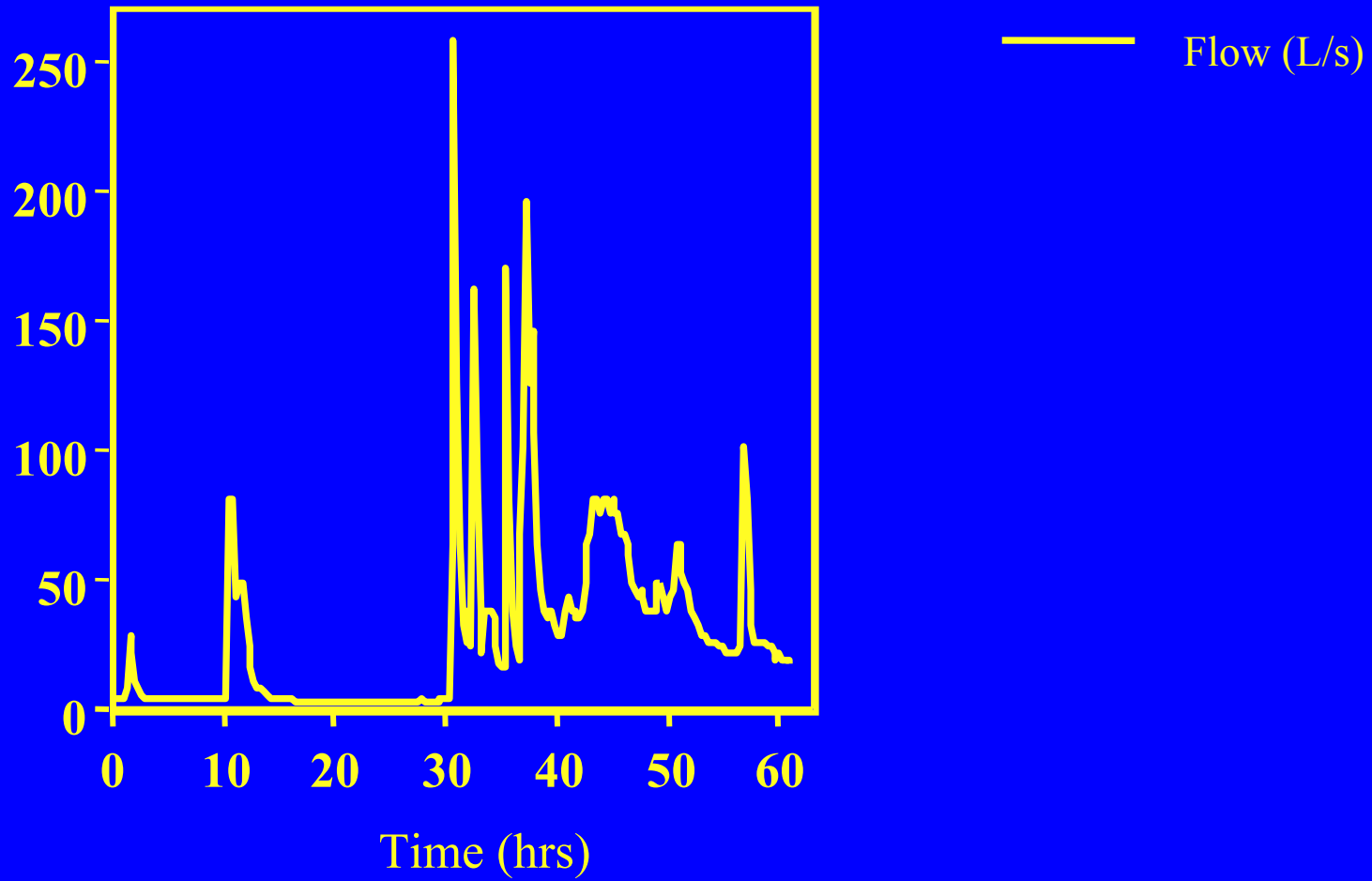
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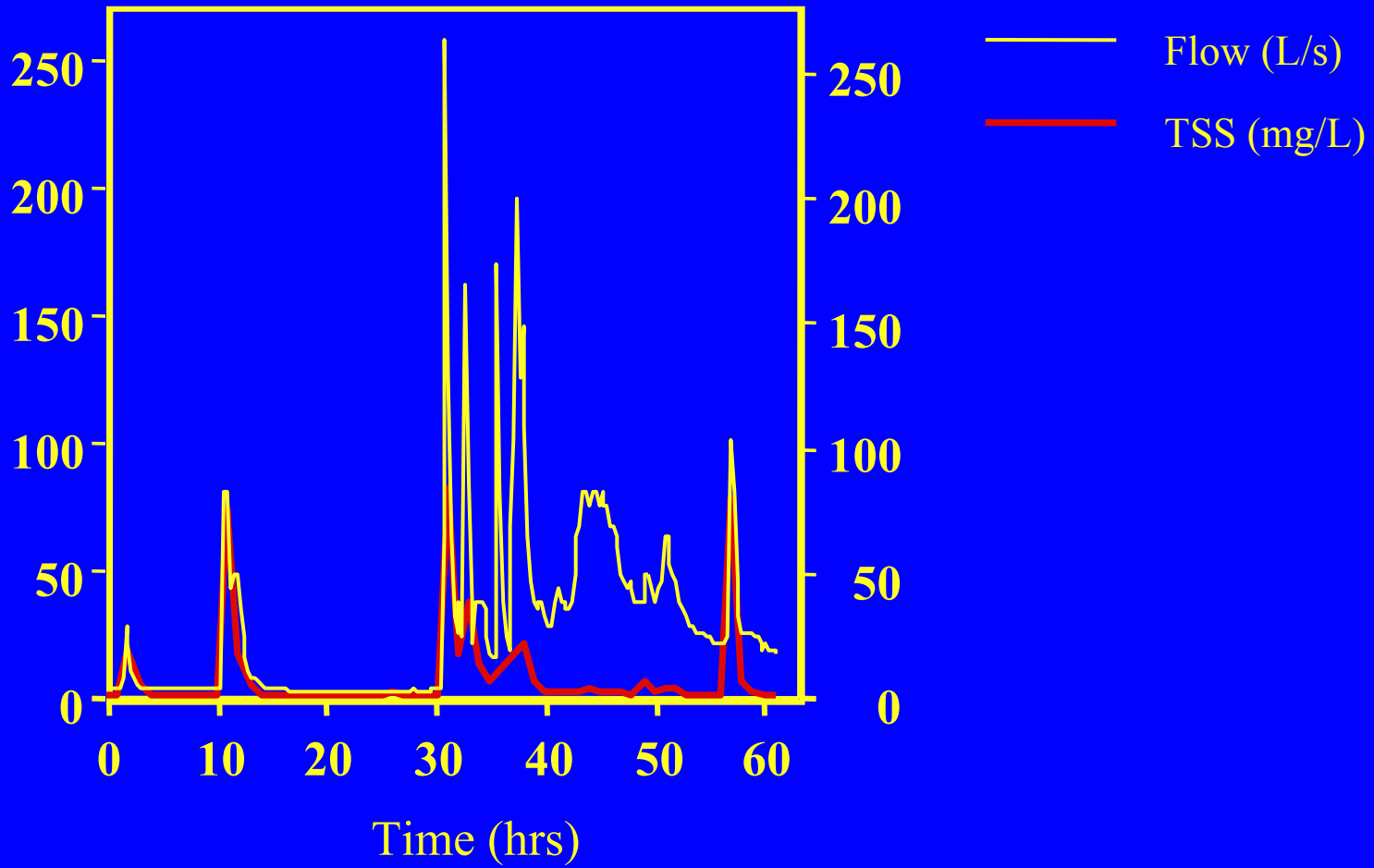
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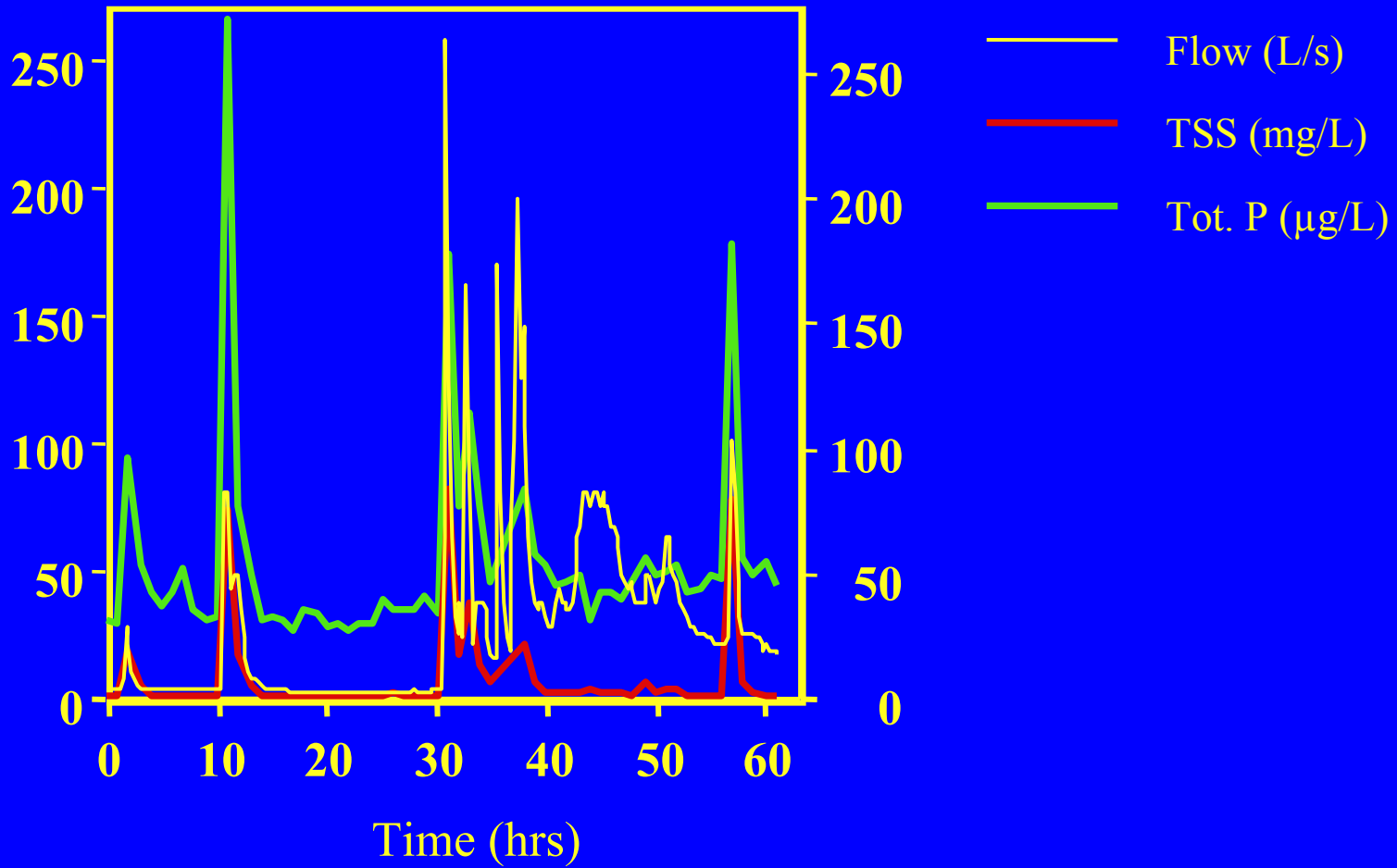
# Urban Stream



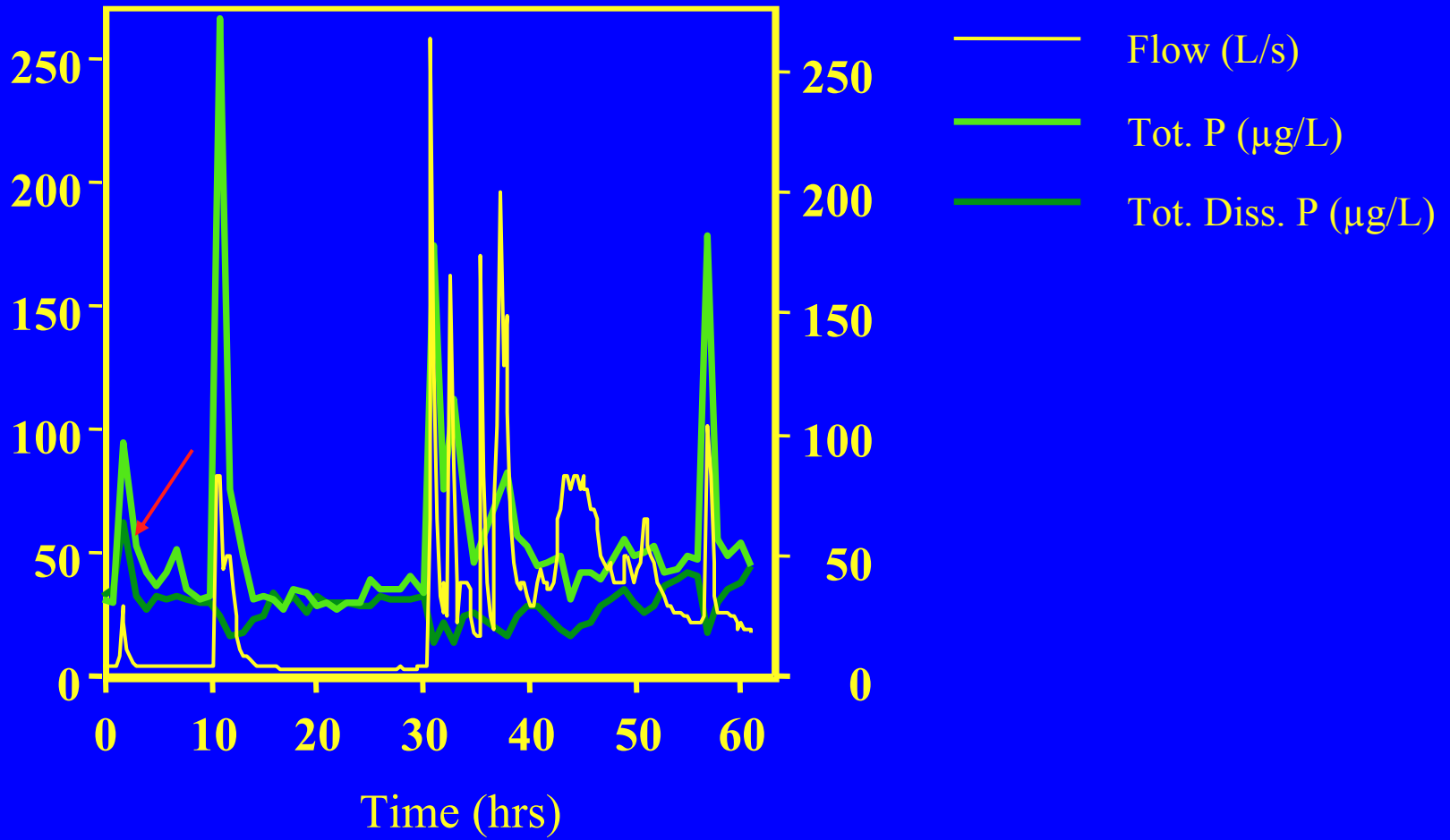
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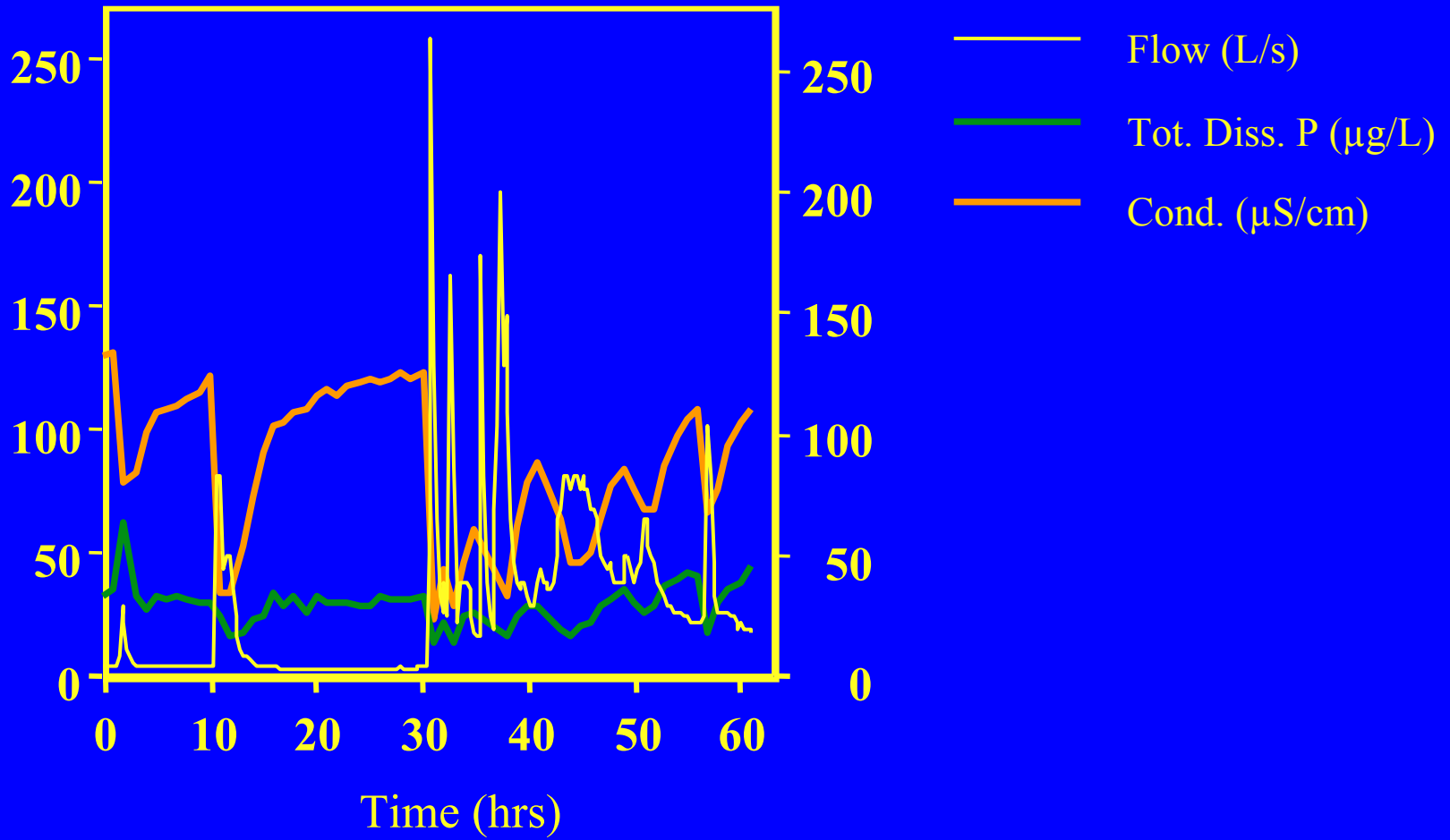
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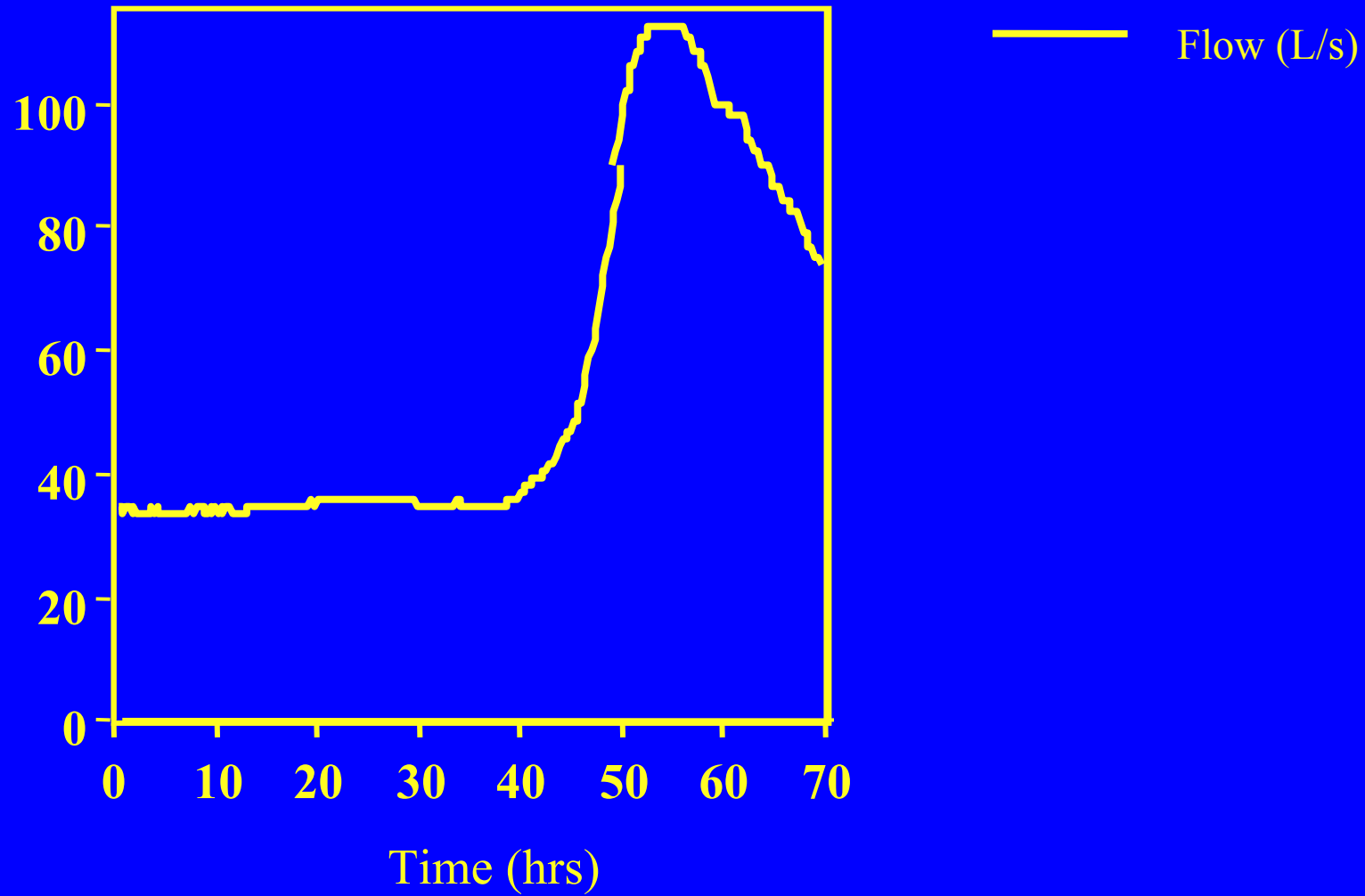
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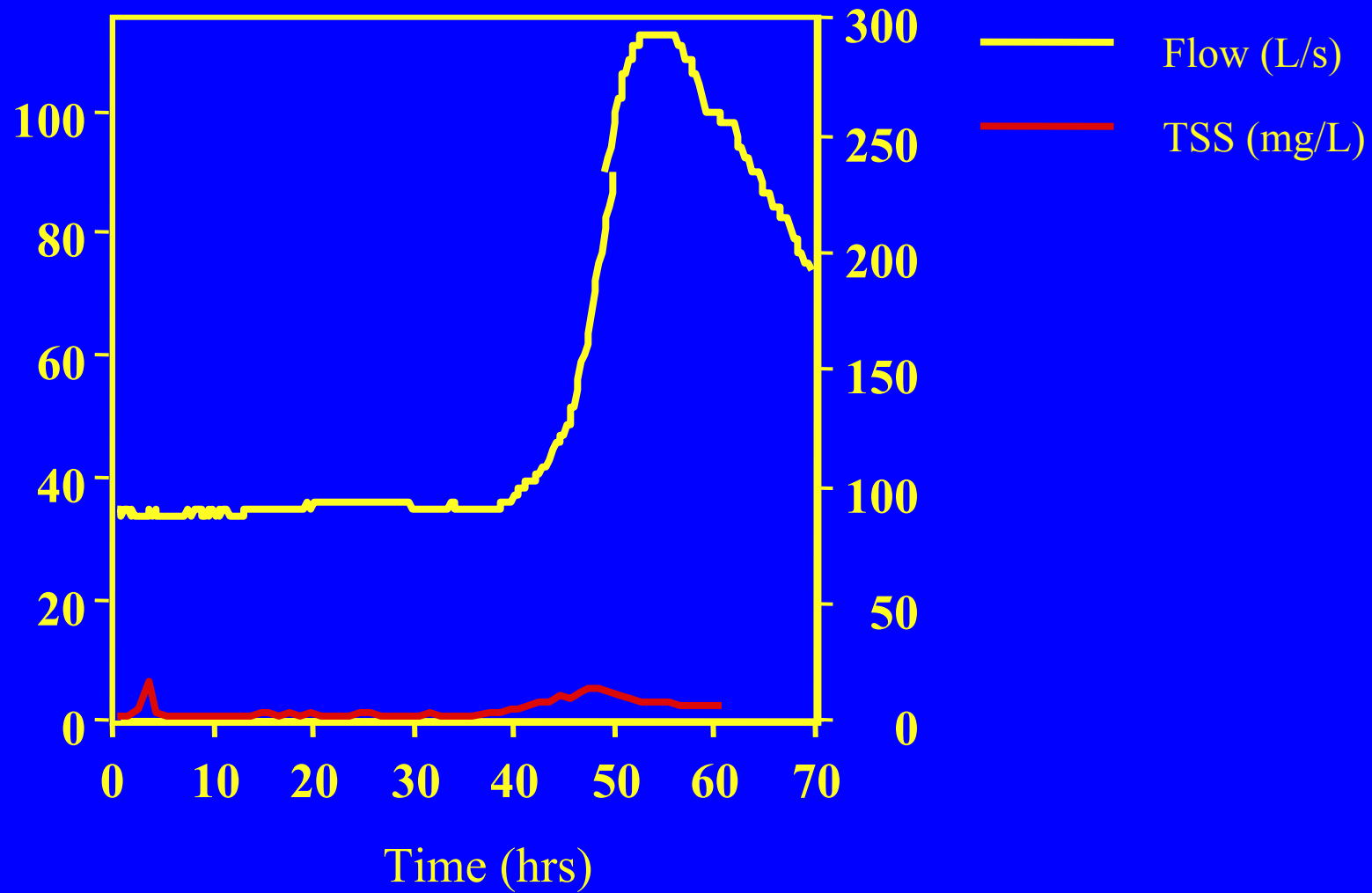
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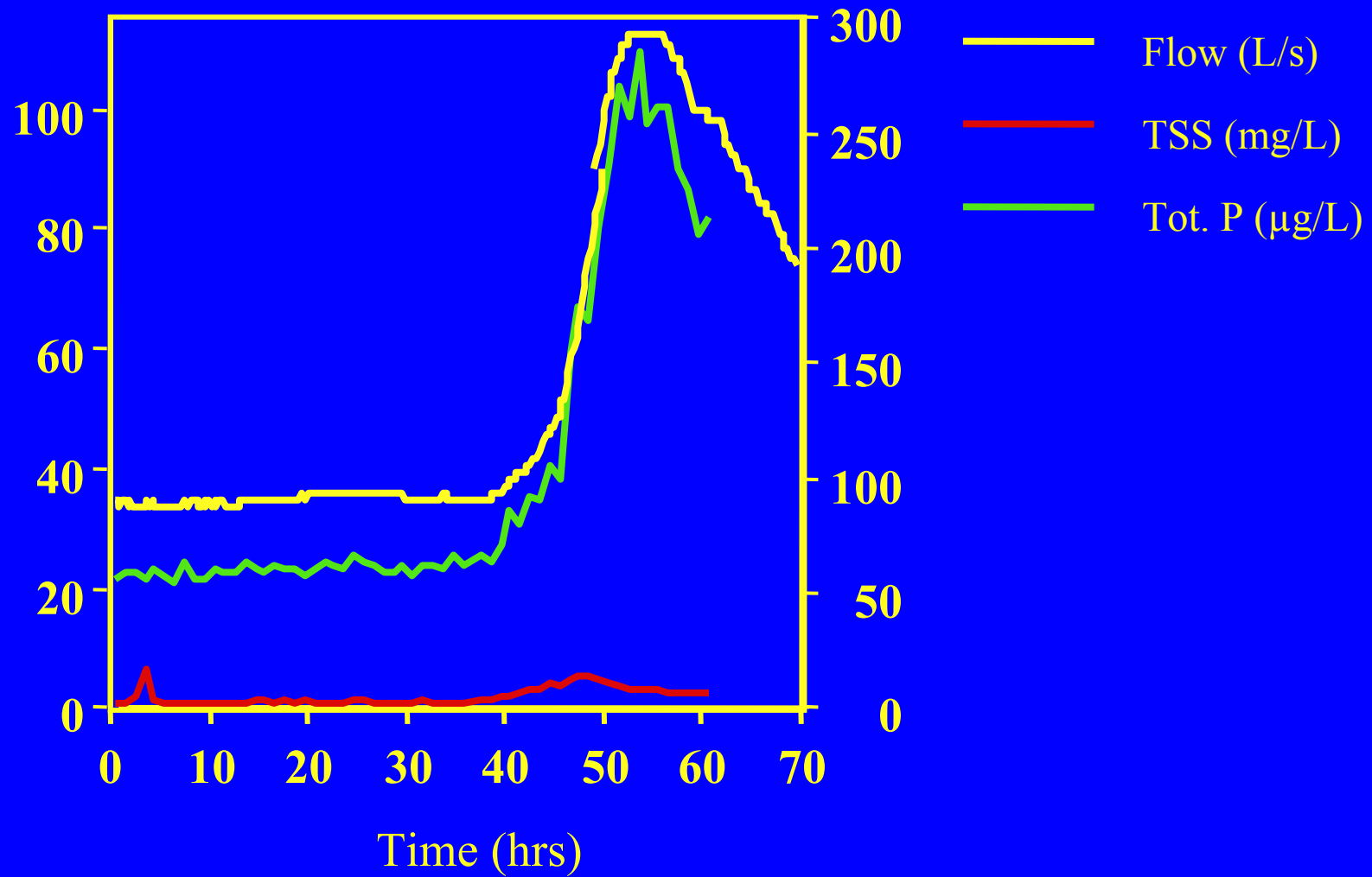
# Agricultural Stream



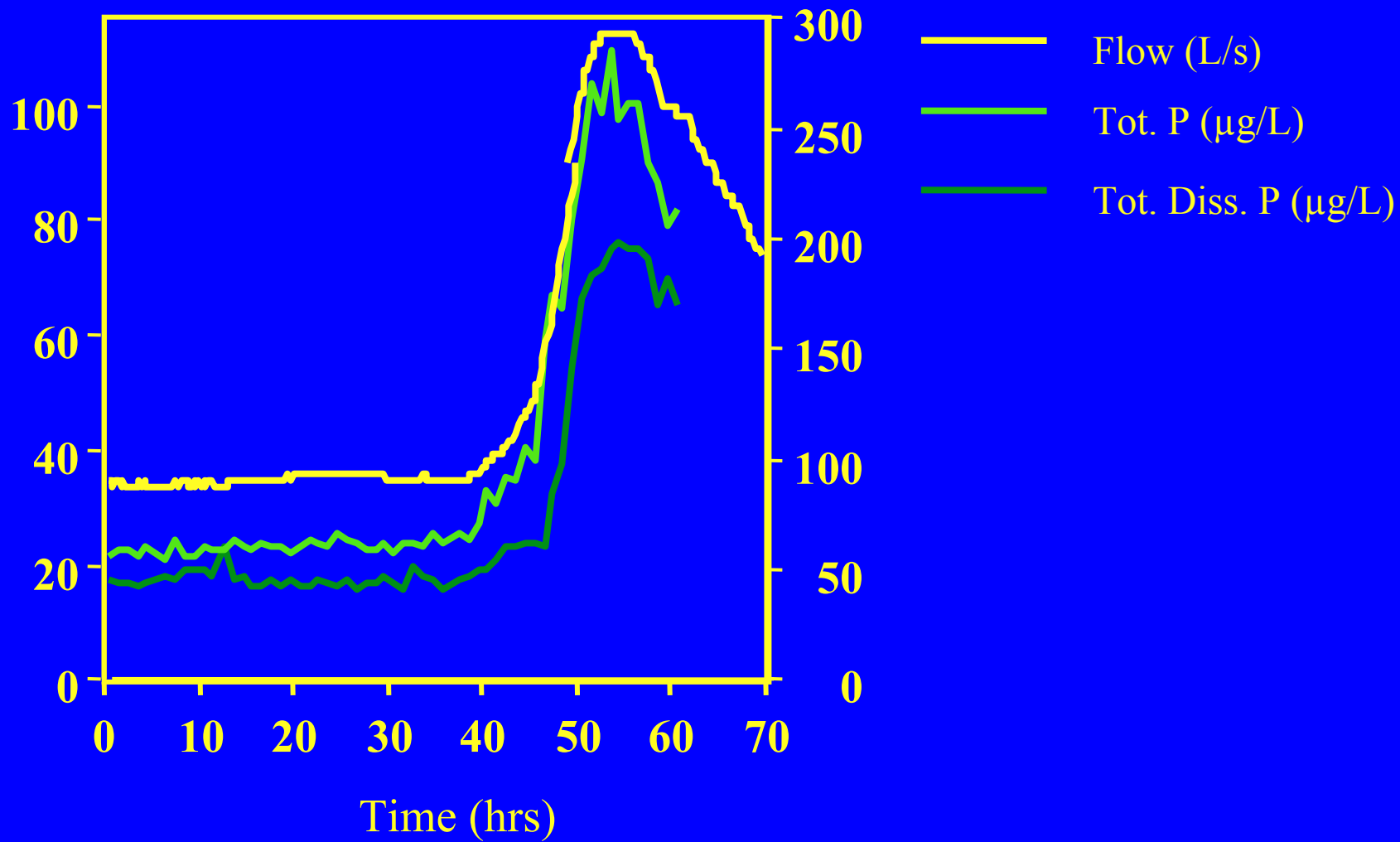
## Agricultural Stream



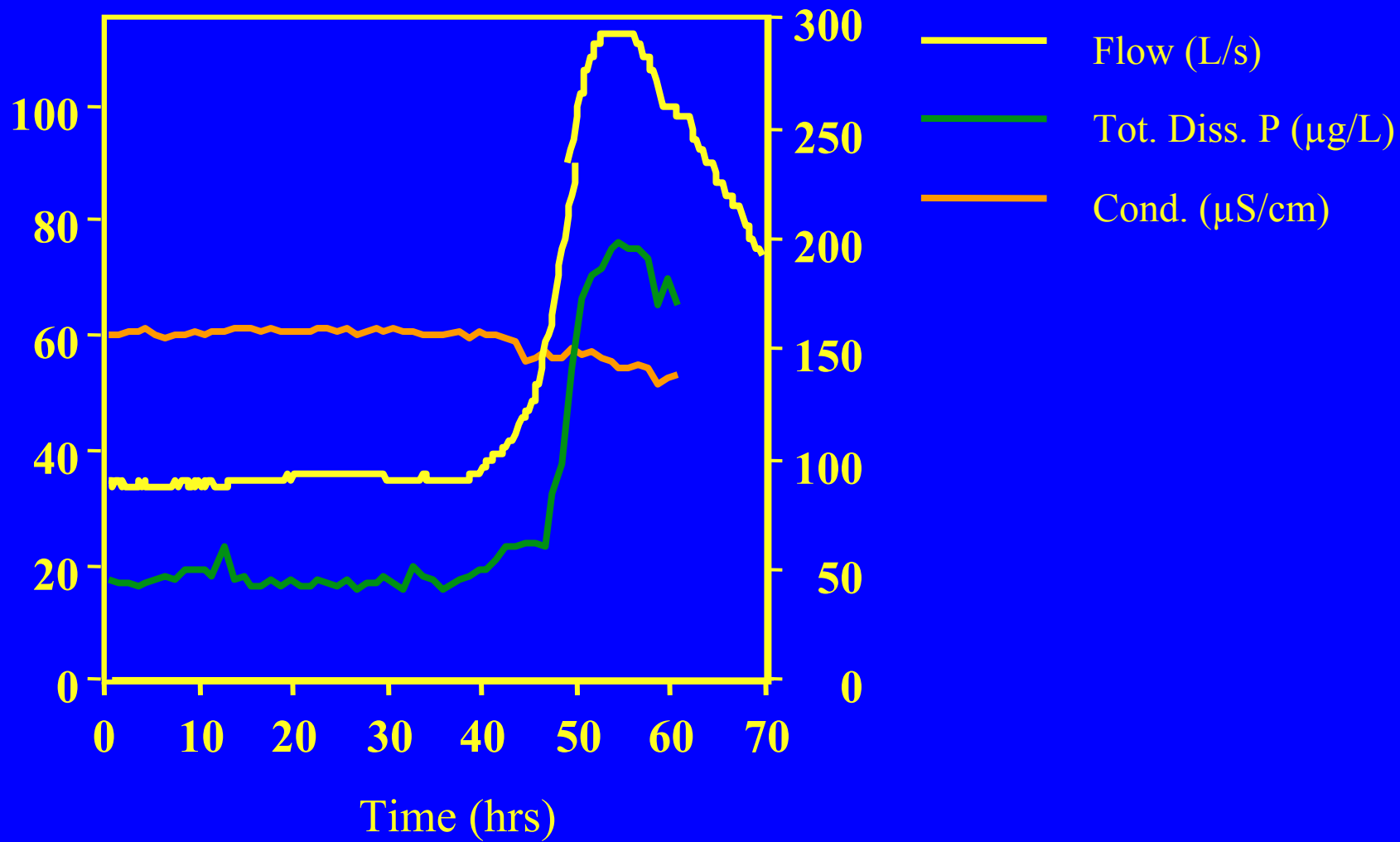
## Agricultural Stream



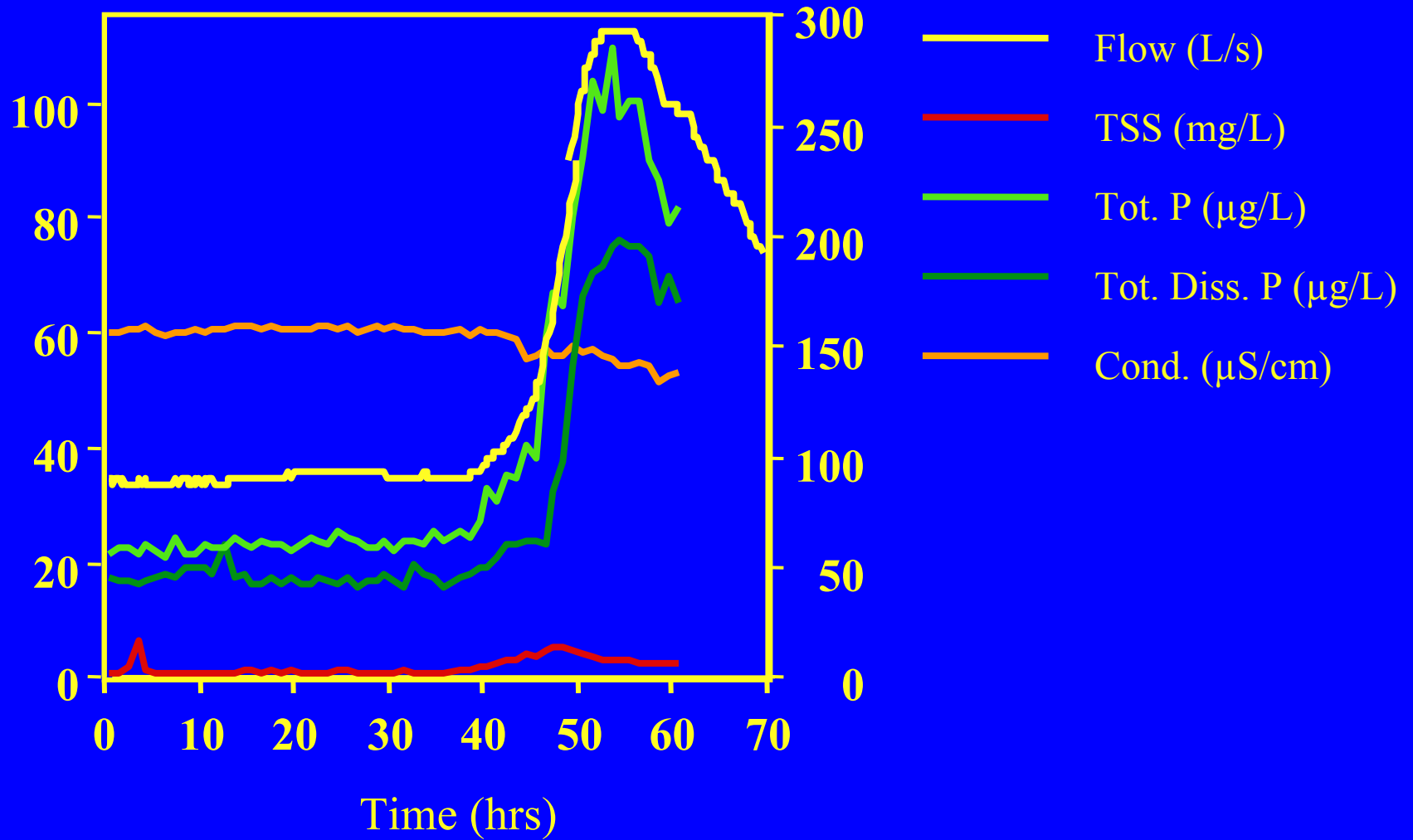
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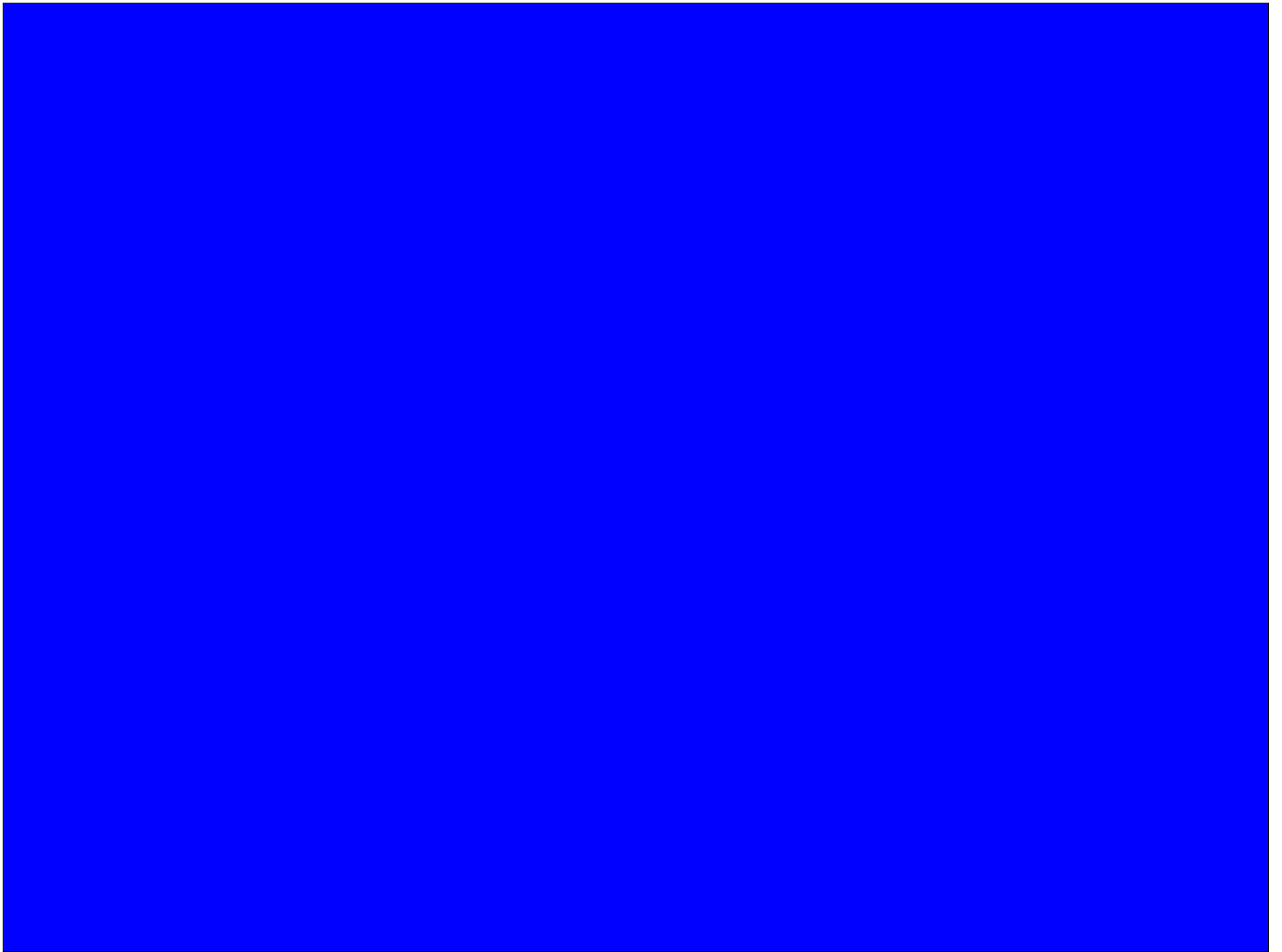
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- **THEREFORE:**

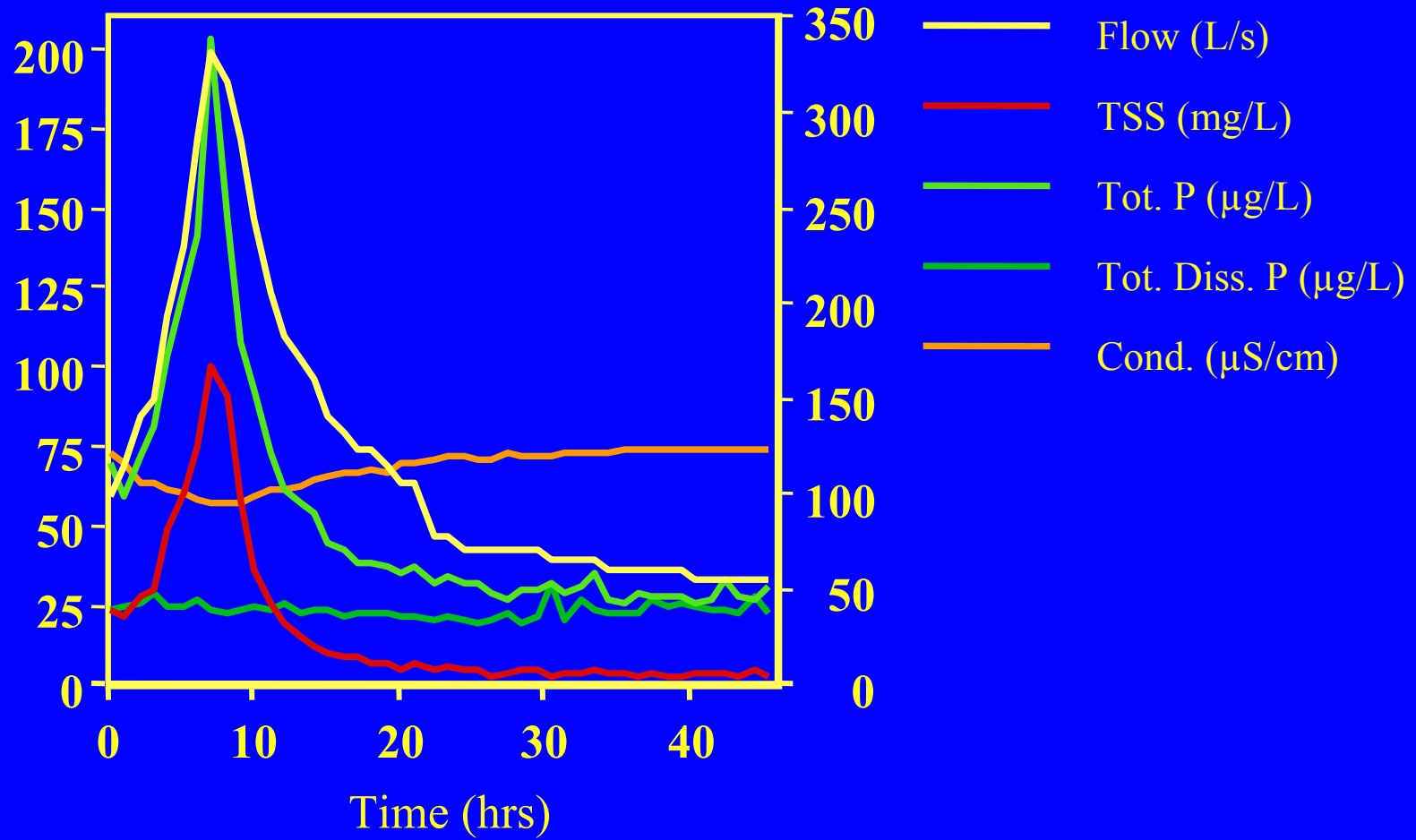
**We need to know how the  
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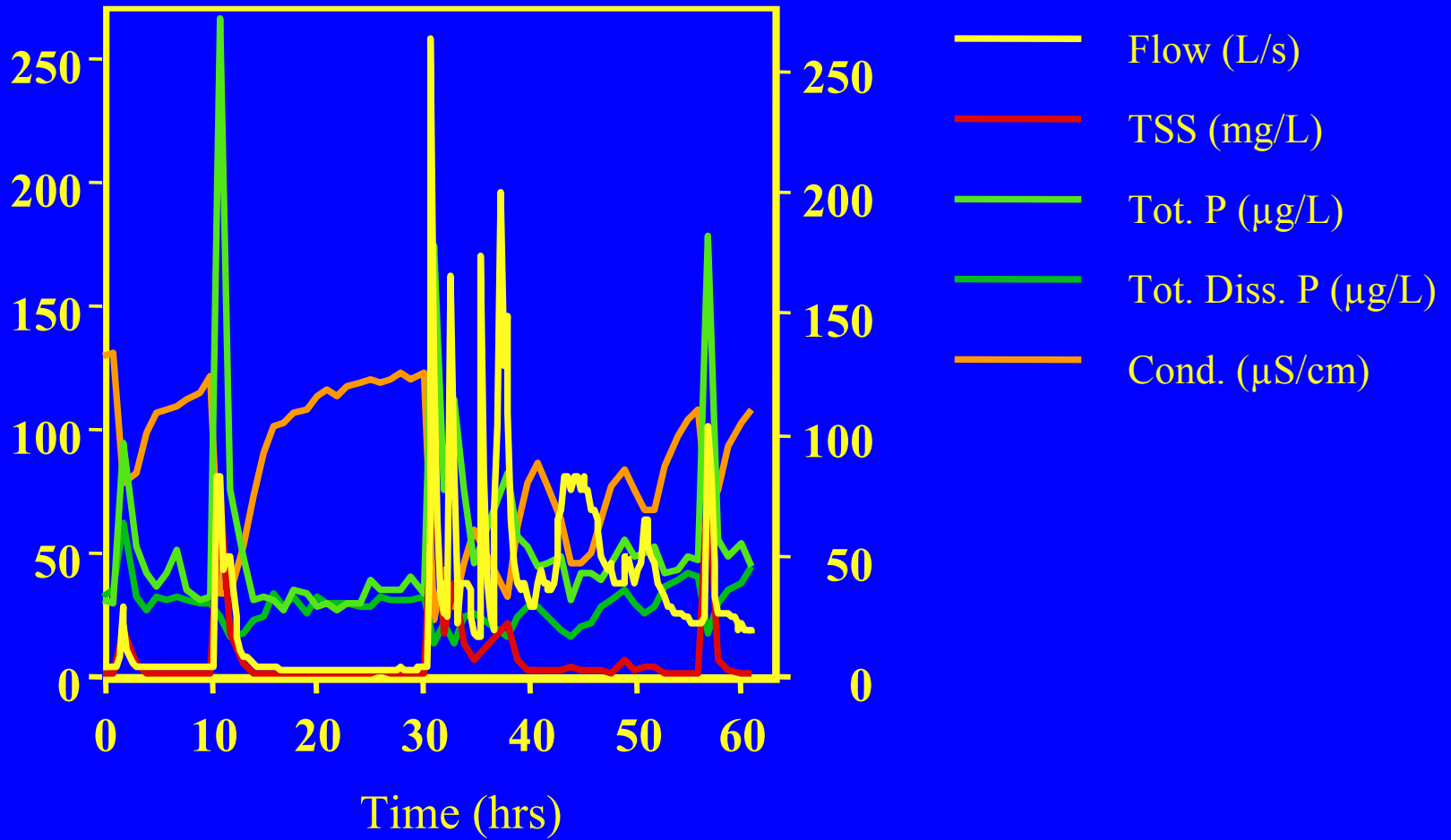
**See Micaela Ellison's poster**



## Forested Stream



# Urban Stream



## Agricultural Stream

