Evaluation of Effective Turbidity Monitoring Methods on Construction Sites

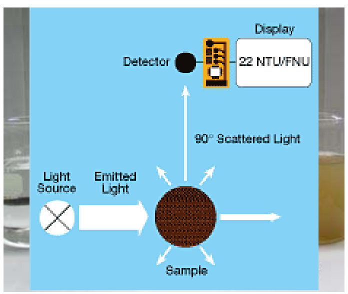
Rebekah Perkins
Bruce Wilson
John Gulliver

March 6, 2013

Outline

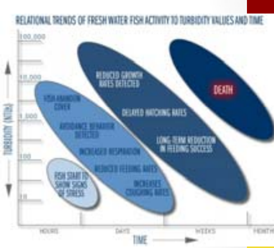
- Introduction
- Project Overview
- Turb. vs. Conc. Relationship
- Application
- Questions

What is Turbidity?



The Problem

- Degrades aesthetic appeal of water bodies
- Impairs sunlight exposure, changing water temperatures
- Hinders aquatic ecosystem health and development



Project Goals

- Simulate realistic runoff and analyze it
- Determine a relationship between turbidity and soil characteristics
- Determine the impact of particle settling on turbidity
- Relate study to realistic site conditions and actual turbidity data
- Use data to help determine a reasonable turbidity limit in Minnesota

Turbidity Monitoring Difficulties

- Construction sites are always changing
- High sediment loads
- Maxed out turbidity readings
- Variable conditions at monitoring locations

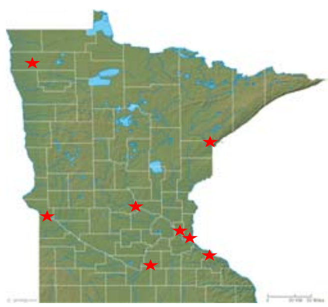
Laboratory Benefits

- Grab samples have limitations
- Limits spatial and weather related problems
- Simulates realistic runoff that can be continuously monitored
- Laboratory experiment is repeatable

Experiment Overview

- Collect 14 soils from 8 locations
- Rain on each soil with a rainfall simulator for ½ hour
- Collect 50 mL samples every 5 minutes for each soil and analyze
- Collect the rest of the runoff in 5 gal bucket and analyze

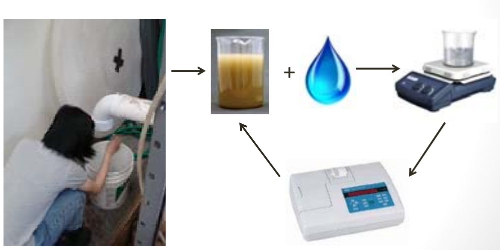
Soil Collection



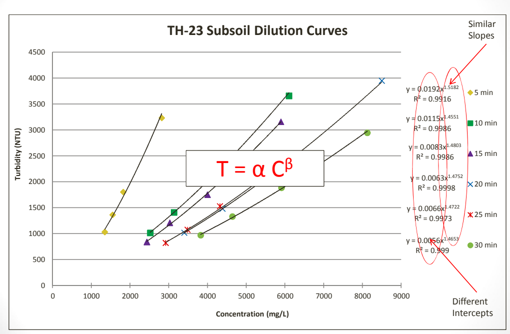
Laboratory Apparatus

Dilution Curves

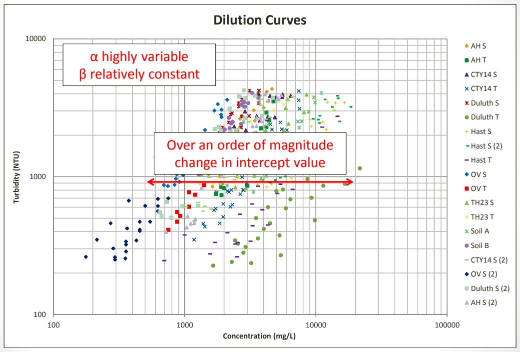
Determination of Turb. vs Conc. Relationship



Dilution Curves



Dilutions Curves – All 14 Soils



Basic Relationship

- Determined α through a regression of soil properties
- Set a fixed power value

$$T = \alpha C^{7/5}$$

$$\alpha = f(\text{\% Silt})$$

Application

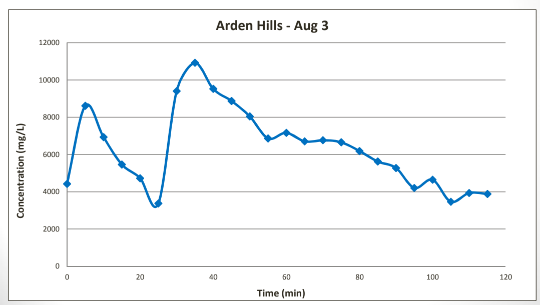
$$T = \alpha C^{7/5}$$

$$\alpha = f(\text{\% Silt, Max Abstraction, Interrill Erodibility})$$

- Determine Turbidity from known or estimated concentration data
- Use continuously monitored turbidity data to estimate concentration and sediment loading
- Know how much sediment removal is needed based on a turbidity standard

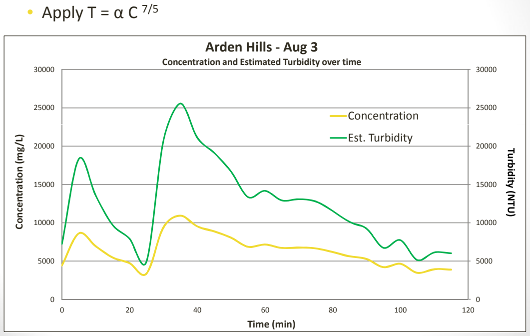
Example 1

Use modeling software (ex. SEDCAD) to estimate concentration over time from a construction site



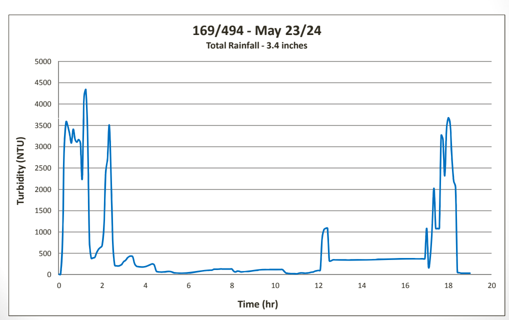
Example 1

- Use regression equation to determine α
- Apply $T = \alpha C^{7/5}$



Example 2

Utilize continuously monitored turbidity data



Example 2

- Obtain site information
- Use regression equation to determine α
- Determine concentration corresponding to an index turbidity value (turbidity standard)

$$C_{index} = \left(\frac{T_{index}}{\alpha}\right)^{5/7}$$

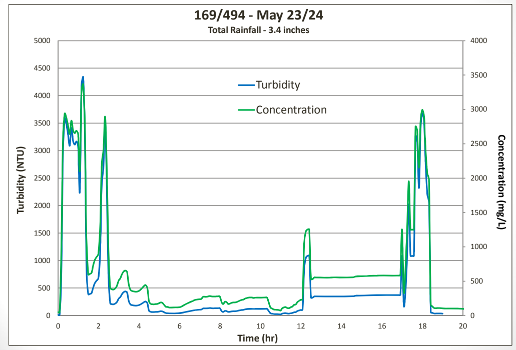
- Determine concentrations corresponding to turbidity data

$$C = C_{index}\left(\frac{T}{T_{index}}\right)^{5/7}$$

- Compare estimated concentration to index concentration

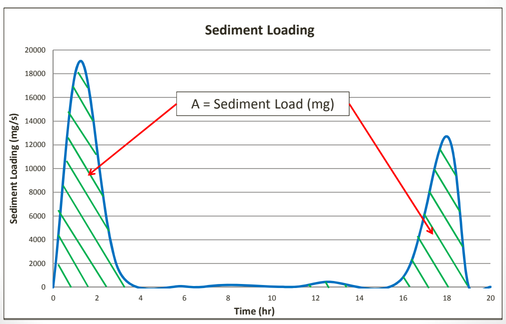
$$\frac{C}{C_{index}} = x$$

Example 2



Example 2

- Using the estimated concentration data and the hydrograph for the storm – estimate sediment load: ***Sediment Load = Q * C***



Summary

- Estimate turbidity
- Estimate concentration
- Estimate sediment loading
- Determine needed sediment removal based on a turbidity standard

$T = \alpha C^{7/5}$

α = f(% Silt, Max Abstraction, Interrill Erodibility)

Acknowledgements

- Minnesota Department of Transportation
- University of Minnesota
- Bruce Wilson
- John Gulliver
- Brad Hansen
- Dwayne Stenlund

Thank you!

Questions?