# How to Control Turbidity on Construction Sites

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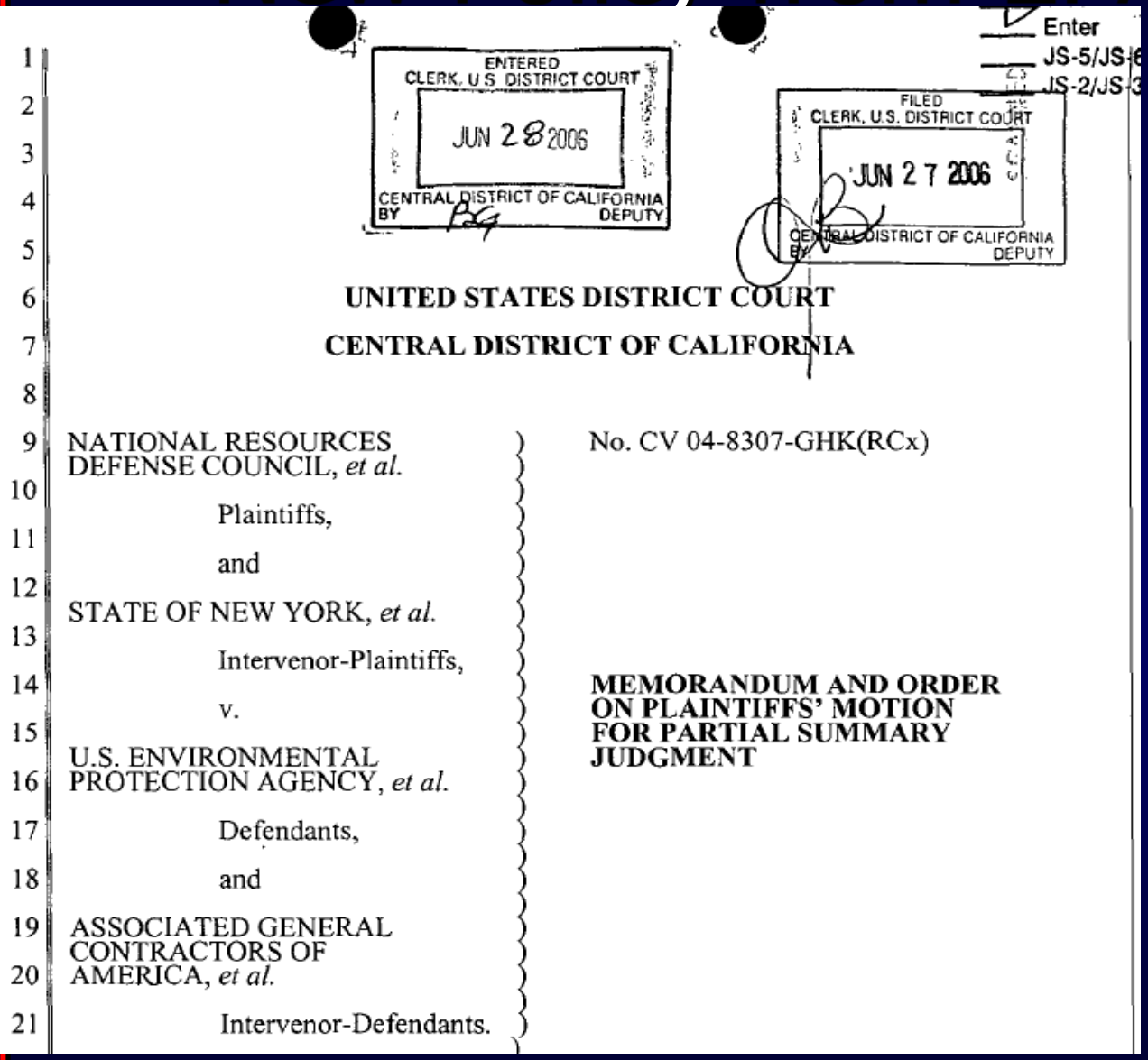
# Traditional Methods of Sediment Control

- Silt fence
- Sediment control fence (stone)
- Diversions
- Riser basin
- Silt basin
- Rock checks
- Stilling basins

# New Policy from EPA This Year



ENTERED
CLERK, U.S. DISTRICT COURT
JUN 28 2006
CENTRAL DISTRICT OF CALIFORNIA
BY DEPUTY

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CLERK, U.S. DISTRICT COURT
JUN 27 2006
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BY DEPUTY

Enter
JS-5/JS-6
JS-2/JS-3

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

NATIONAL RESOURCES DEFENSE COUNCIL, *et al.*

Plaintiffs,

and

STATE OF NEW YORK, *et al.*

Intervenor-Plaintiffs,

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, *et al.*

Defendants,

and

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, *et al.*

Intervenor-Defendants.

No. CV 04-8307-GHK(RCx)

**MEMORANDUM AND ORDER ON PLAINTIFFS' MOTION FOR PARTIAL SUMMARY JUDGMENT**

- Need to set Effluent Limit Guidelines (ELGs) and New Source Performance Standards (NSPS)

# Proposed ELG

- 10+ acres need a sediment basin.
- 30+ acres, >10% clay, R= 50…must achieve 13 NTU
- California has proposed a similar rule

# Final Rule for ELG (11/23/09)

- 280 NTU daily average in discharge for:
  - 30+ acres now, 20+ acres in 18 months, 10+ acres in 4 yrs
  - < 2 year storm event over 24 hours (greater amounts are exempt). Must treat even if >2 yr storm.
- Surface outlets required
- 7-14 days after grading (depending on slope) requires groundcover.

# Final Rule for ELG (11/23/09)

- Passive treatment is presumed to accomplish the 280 NTU limit.
- Estimated additional cost of <0.1% of annual construction activity.
- 21,000 projects affected annually
- Rule is a minimum – more is up to states.
- Sampling required, not specified.

# Surface Outlet (Skimmer)

# Skimmer Basin Functions

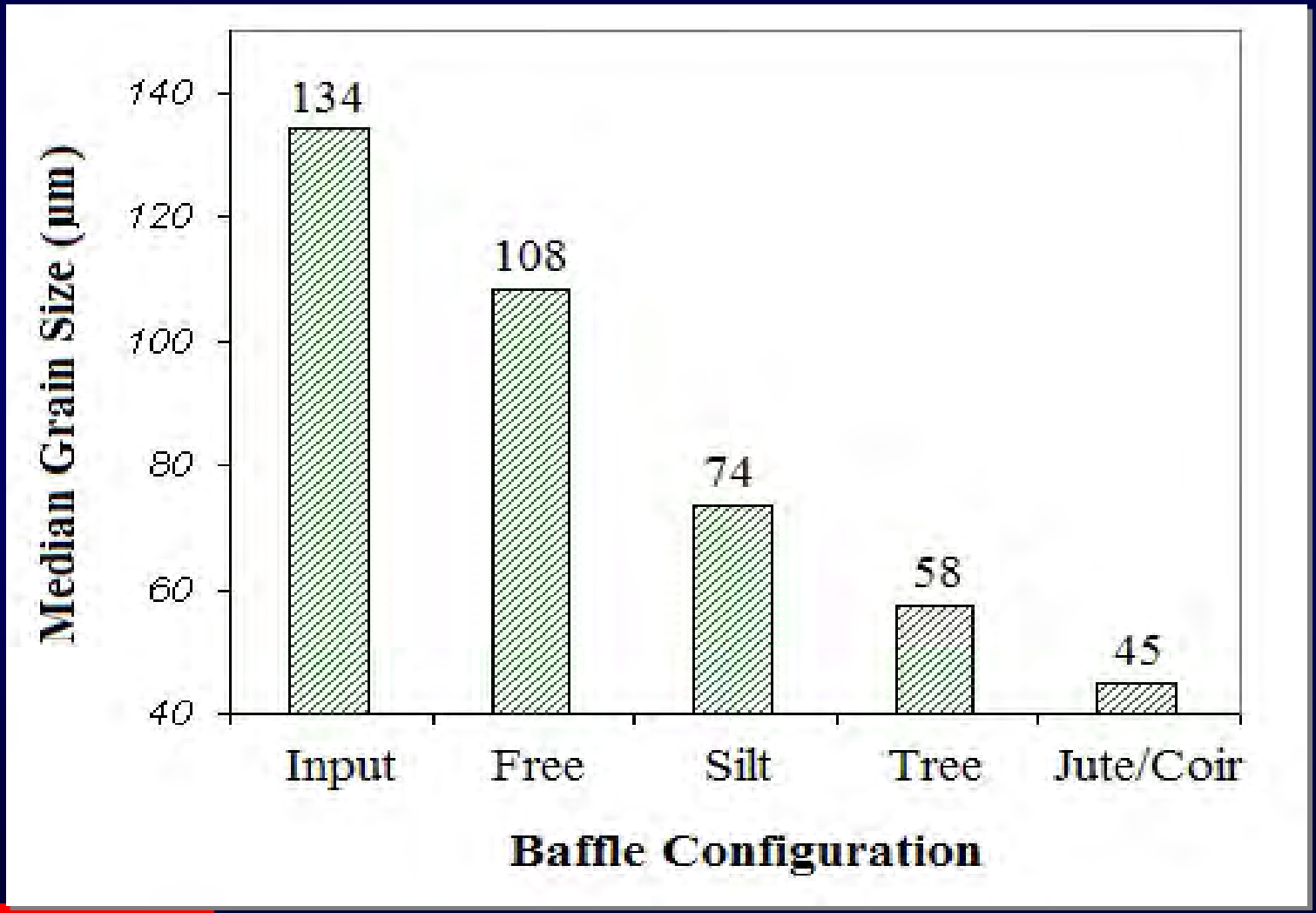
- Skimmer backs up inflow to create pool
- Pool acts to slow flow and drop sediment
- Basin dewater primarily over emergency spillway!
- Skimmer dewaters basin once inflow ceases.
  - Allows sediment to dry between storms
  - Reduces standing water (liability, mosquitoes)

# Baffles

700 g m2 coir

Not too much…

# Effects of Baffles: Grain Capture

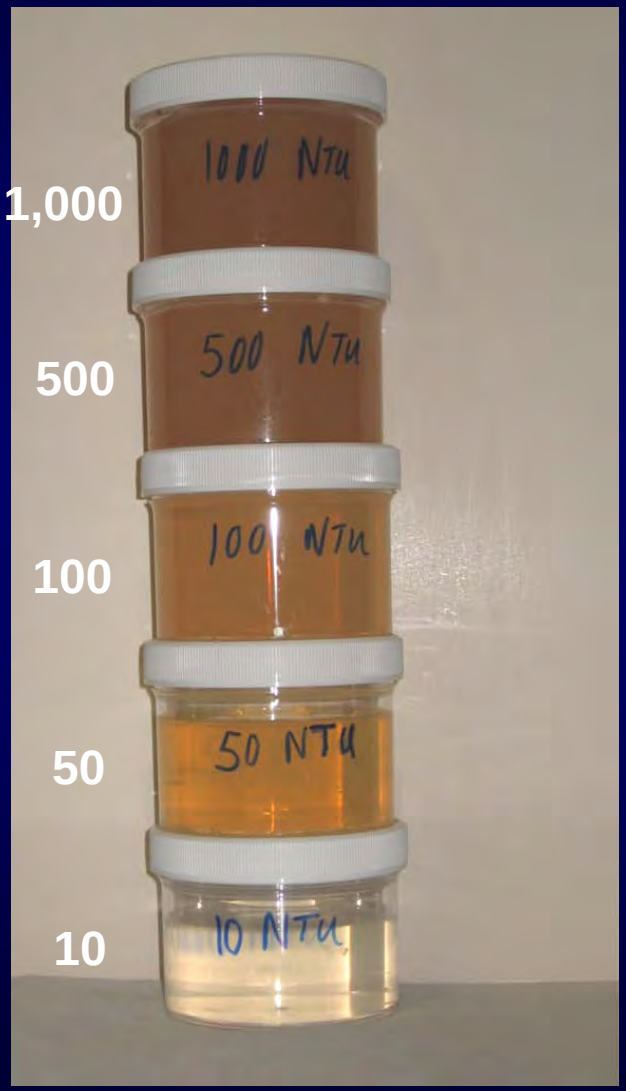


# Improvement from Surface Outlet/Porous Baffles

- May increase sediment capture from 60% to 90%.
- This will increase maintenance needs.
- Turbidity will still be an issue

# Current Turbidity Rule Interpretation

- Receiving water <10/25/50, discharge has to be <10/25/50.
- Receiving water >10/25/50, discharge cannot increase it.

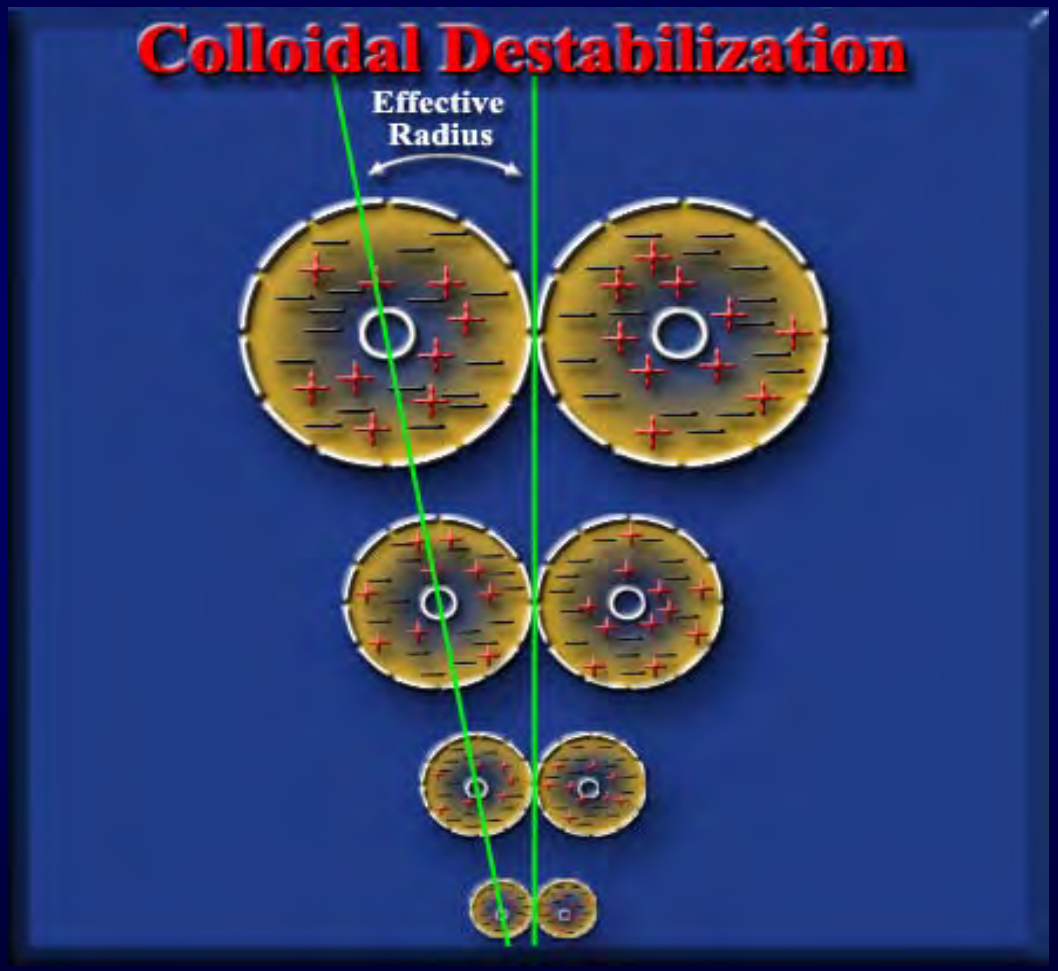


# Particle Settling Times

| Typical | Size (mm) | Surf. Area | 1 m Fall Time |
|---|---|---|---|
| Gravel | 10. | 3.14 $cm^2$ | 1 sec |
| Coarse Sand | 1. | 31.4 $cm^2$ | 10 sec |
| Fine Sand | 0.1 | 314 $cm^2$ | 125 sec |
| Silt | 0.01 | 0.314 $m^2$ | 108 min |
| Bacteria | 0.001 | 3.14 $m^2$ | 180 hr |
| Colloid | 0.0001 | 31.4 $m^2$ | 755 days |

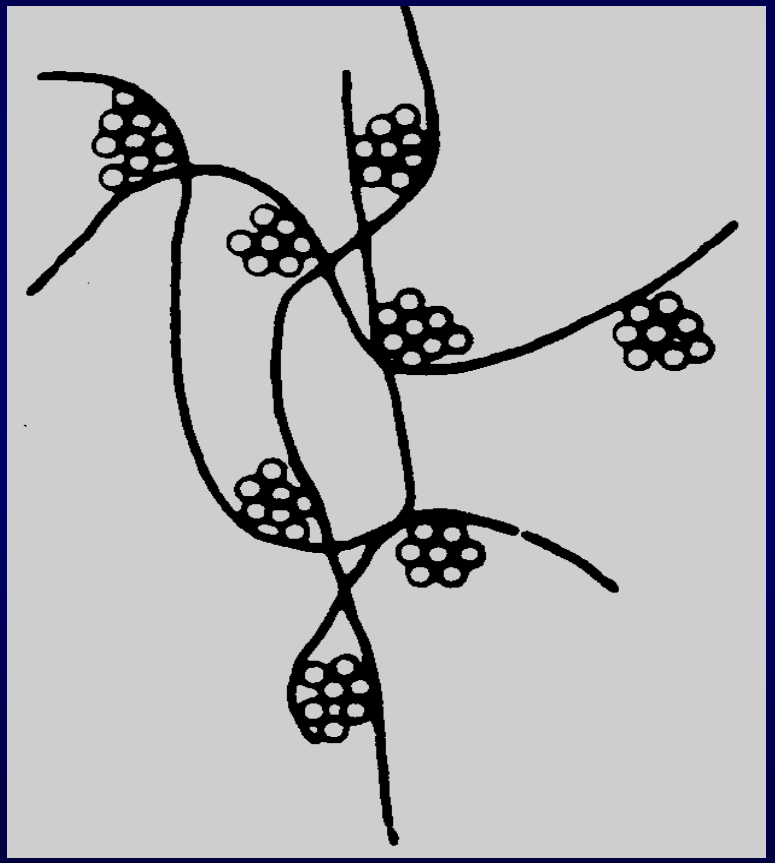
# *Coagulation*

Destabilization of colloids by neutralizing the forces that keep the particles apart



# *Flocculation*

The agglomeration, or building up of smaller particles into larger size flocs that are able to settle out of the suspending liquid more rapidly.

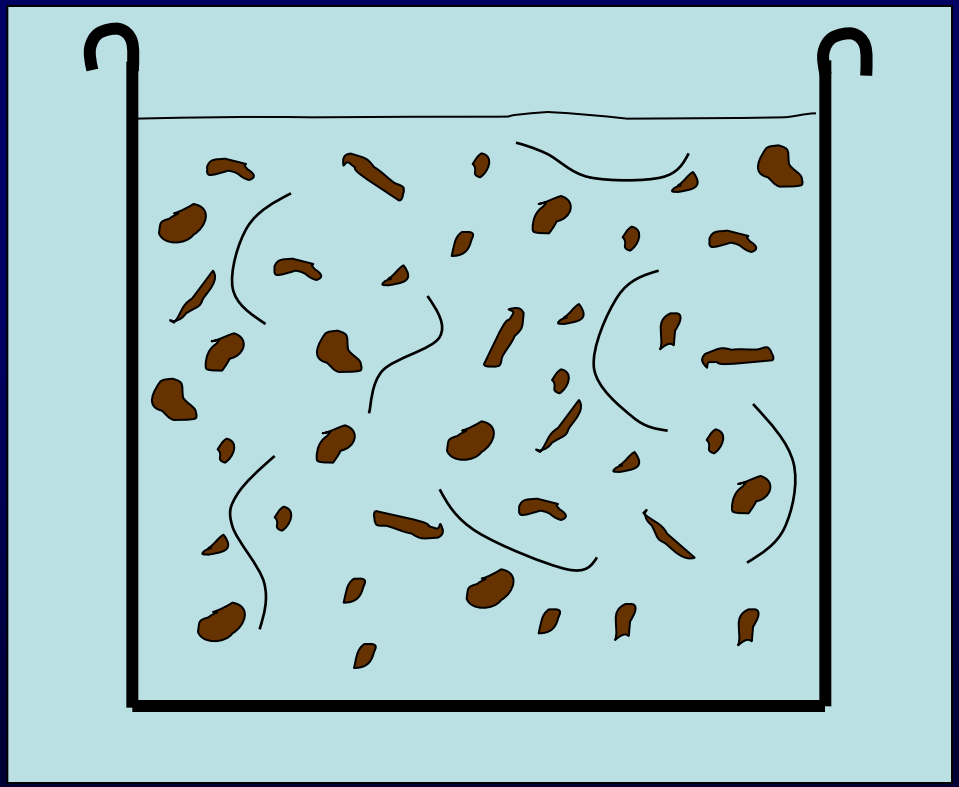


# Flocculation

- Rate of flocculation is dependent upon
  - Collision frequency
  - Collision efficiency
- Factors affecting collisions
  - Mixing energy
  - Mixing time
  - pH
  - Temperature
  - Quantity of particles
  - Type and dosage of flocculant used

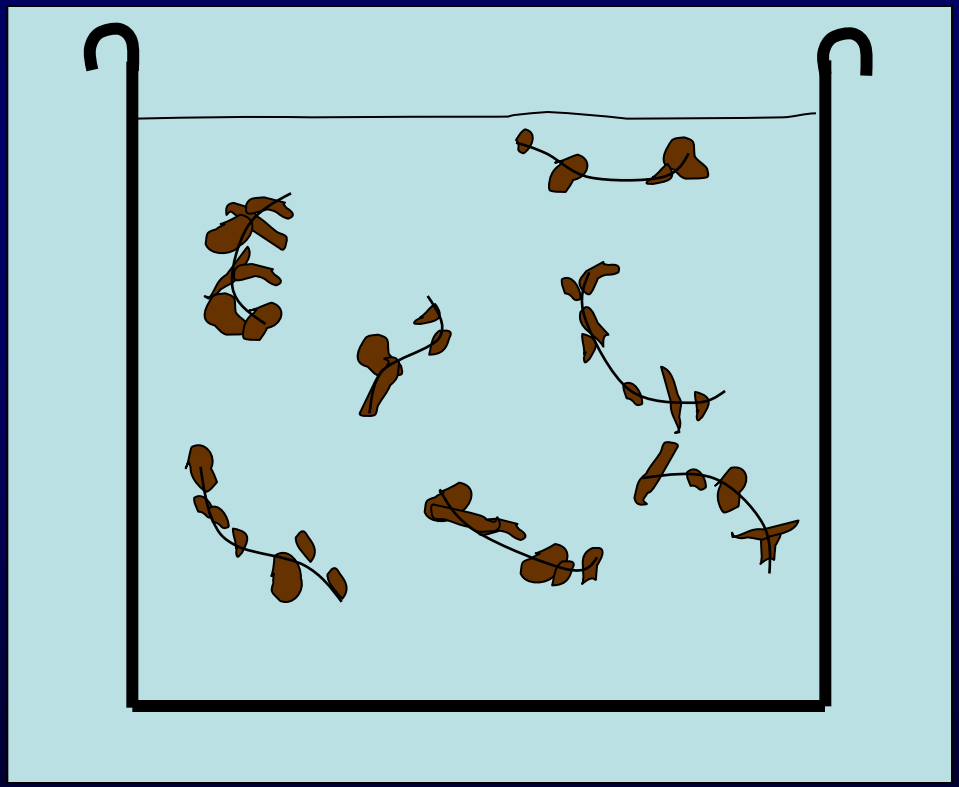
# Flocculation by PAM

- PAM flocculates suspended sediment by binding to several soil particles forming a larger aggregate or floc



# Flocculation by PAM

- The large flocs then settle out of suspension



# *Mixing Energy*

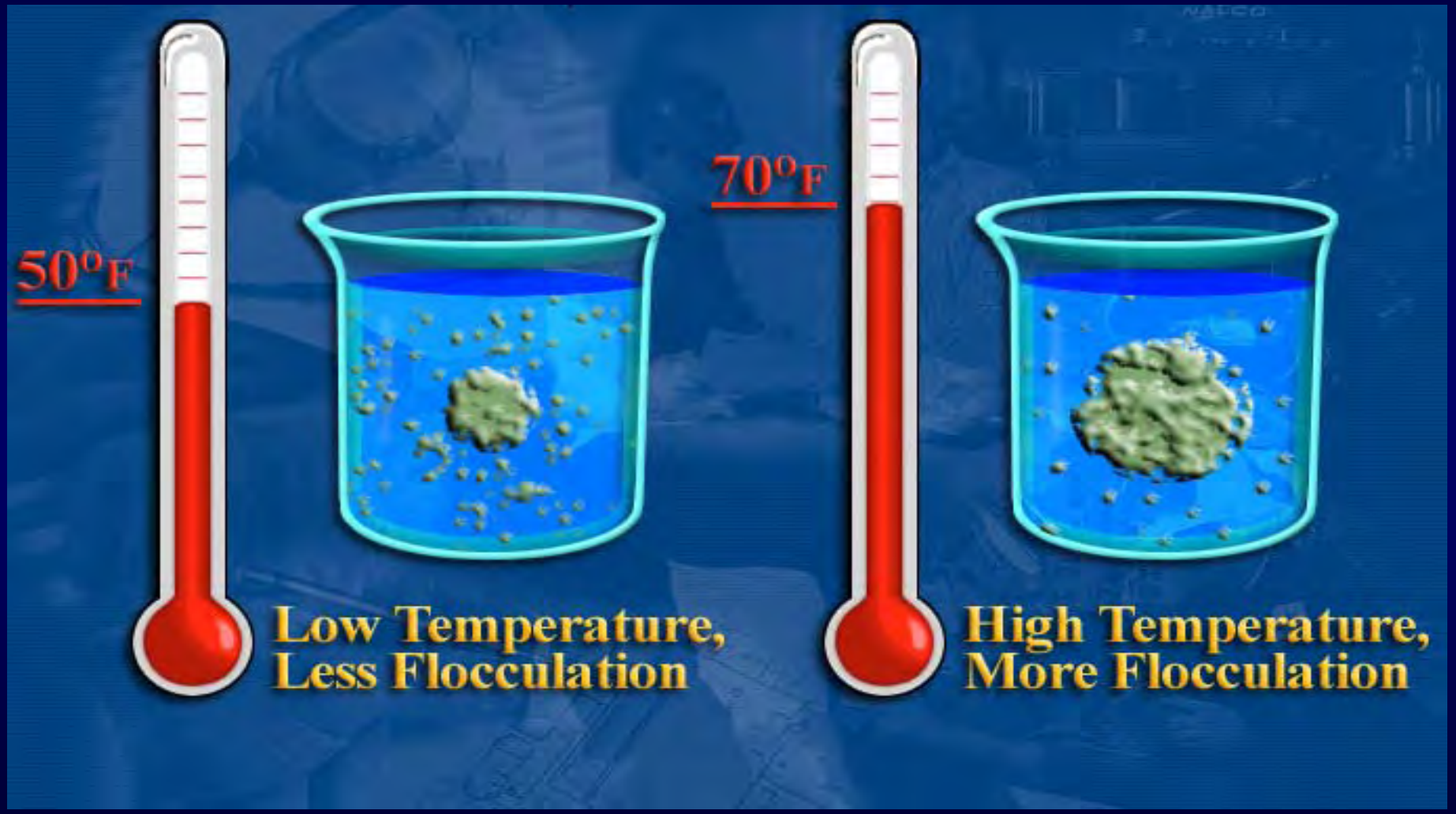
Mixing energy has a direct effect on the number and efficiency of collisions.

- Insufficient mixing will have a negative impact on the number of contacts and the resultant floc formation will be impaired.
- Too much mixing will also have a negative impact as it can destroy a stable floc.

# *Mixing Time*

Mixing time refers to the amount of time the mixture is allowed to flocculate, and has a direct impact on the number of collisions. The longer the flocculation time, the more chances for floc growth.

# Temperature



# *Polymer Forms*

- Liquid
  - Solution – dissolved in water
  - Dispersion – suspended in a salted water solution
  - Emulsion – emulsified in oil

# *Solid Polymer Forms*

Powder

Solid Block

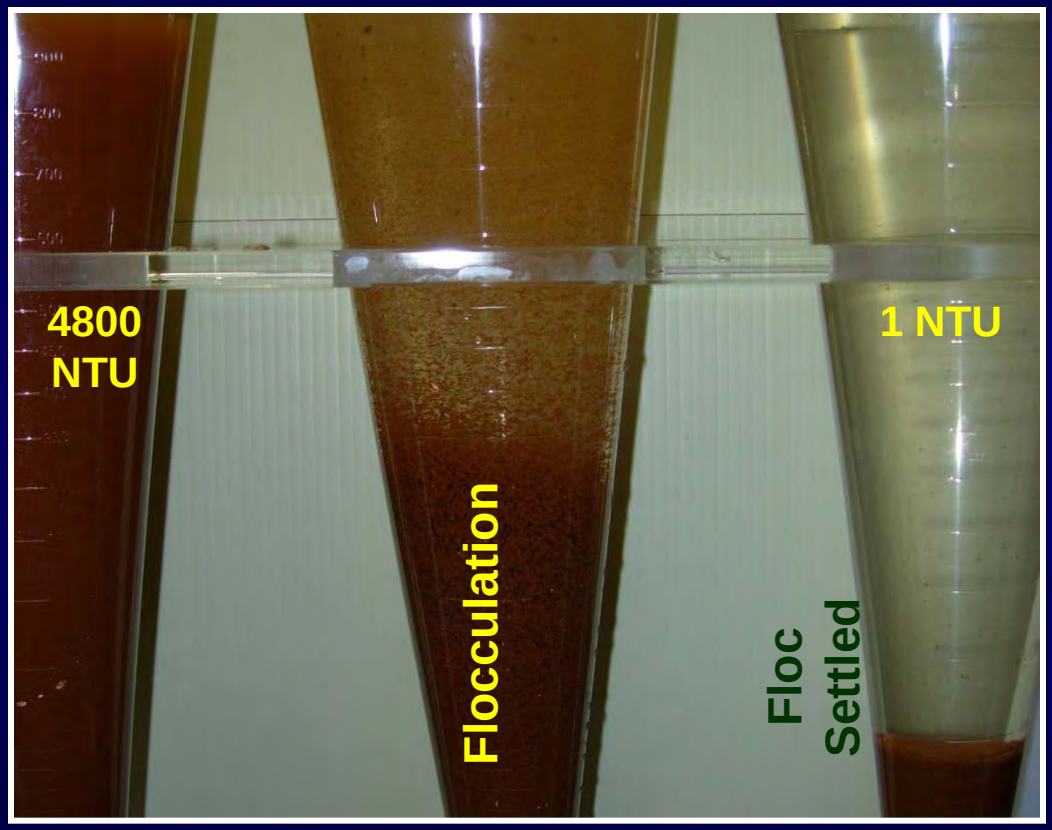
# Not Available As a Spray...

# *Polymer Testing*

- Jar test with sediment or muddy water
- Usually want to test a variety of products or chemistries.
- Looking for rapid flocculation and settling.
- We will do this later...

# Flocculation

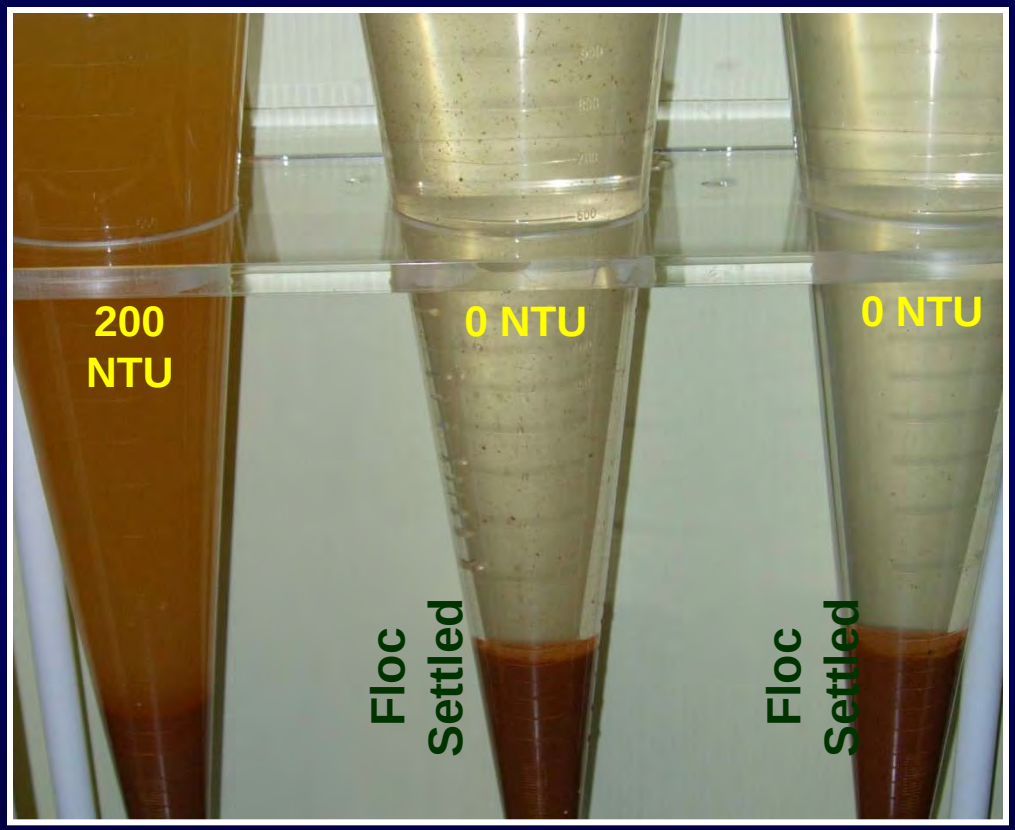
## 15 Seconds




Pre-treatment
4800 NTU

Post-treatment
1 NTU

## 7 Hours




Pre-treatment
200 NTU

Post-treatment
0 NTU

Must let flocs settle out before discharging water off site!

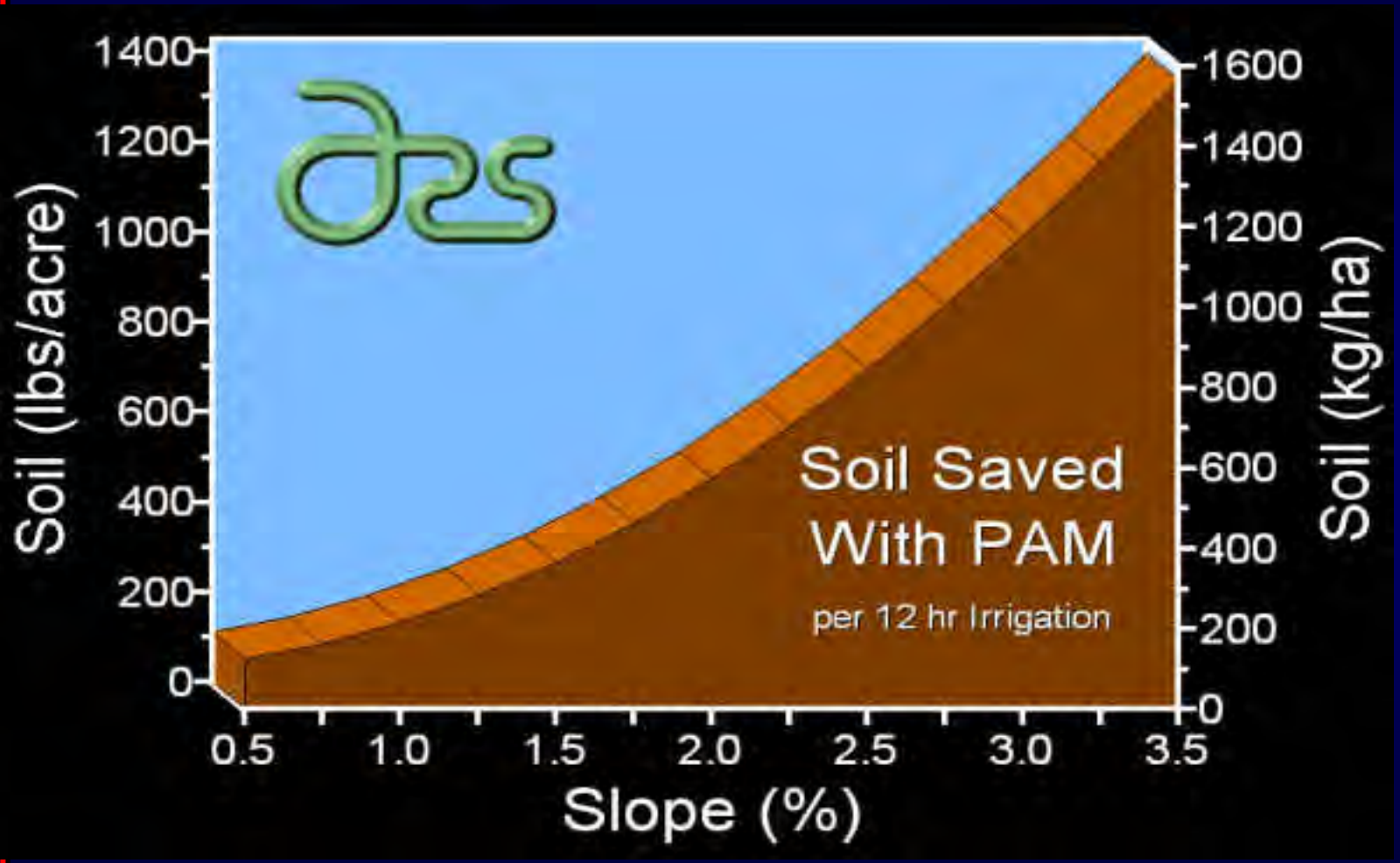
# Flocs

# Erosion Control Enhancement with PAM on Construction Sites

Melanie McCaleb, MS, CPESC

# USDA Promotes PAM

# Furrow Irrigation Application




94% Reduction
In Furrow Erosion

# Steep Slope PAM Studies

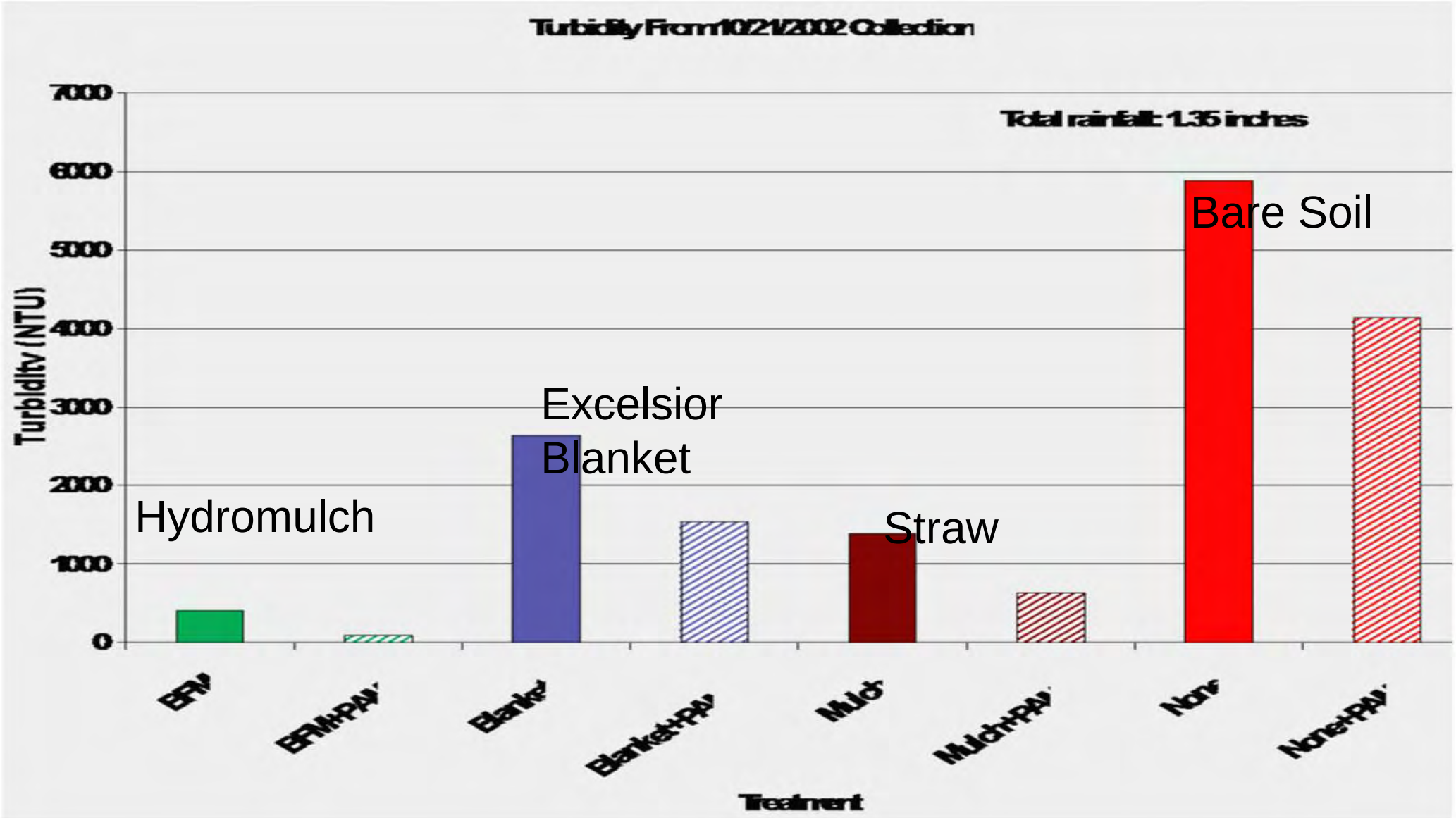
| Study | Slope (%) | PAM Rate (kg/ha) | Ground Cover | Sediment Reduction (%) | Runoff Reduction (%) |
|---|---|---|---|---|---|
| Flanagan et al., 2002a | 32 | 80 | None | 83-91 | 40-52 |
| Flanagan et al., 2002b | 35-45 | 80 | None | 40-54 | 28-32 |
| Soupir et al., 2004 | 5 | 6.7-20 | None | 28-82 | -50 to 2 |
| Hayes et al., 2005 | 20-33 | 11.4 | Straw<br>None | -560 to 44<br>-10 to 43 | -300 to 60<br>-180 to -35 |
| McLaughlin and Brown, 2006 | 10<br>20 | 19<br>19 | Straw<br>Straw | 13 to 93*<br>67 to 80* | Not reported |
| Chochrane et al., 2005 | 8-12 | 20 | None | 87 | Not reported |
| Zhang et al., 1998 | 6 | 20 | None | 19 | 44 |
| Tang et al., 2006 | 15 | 20 (+ phosphogypsum) | None | 50-75 (estimated from graphs) | 50-75 (estimated from graphs) |
| Partington and Mehuys, 2005 | 30 | 10-20 | None | 76-84<br>99* | Not reported |
| Peterson et al., 2002 | 17 | 60 | None | 93-98 | 62-76 |

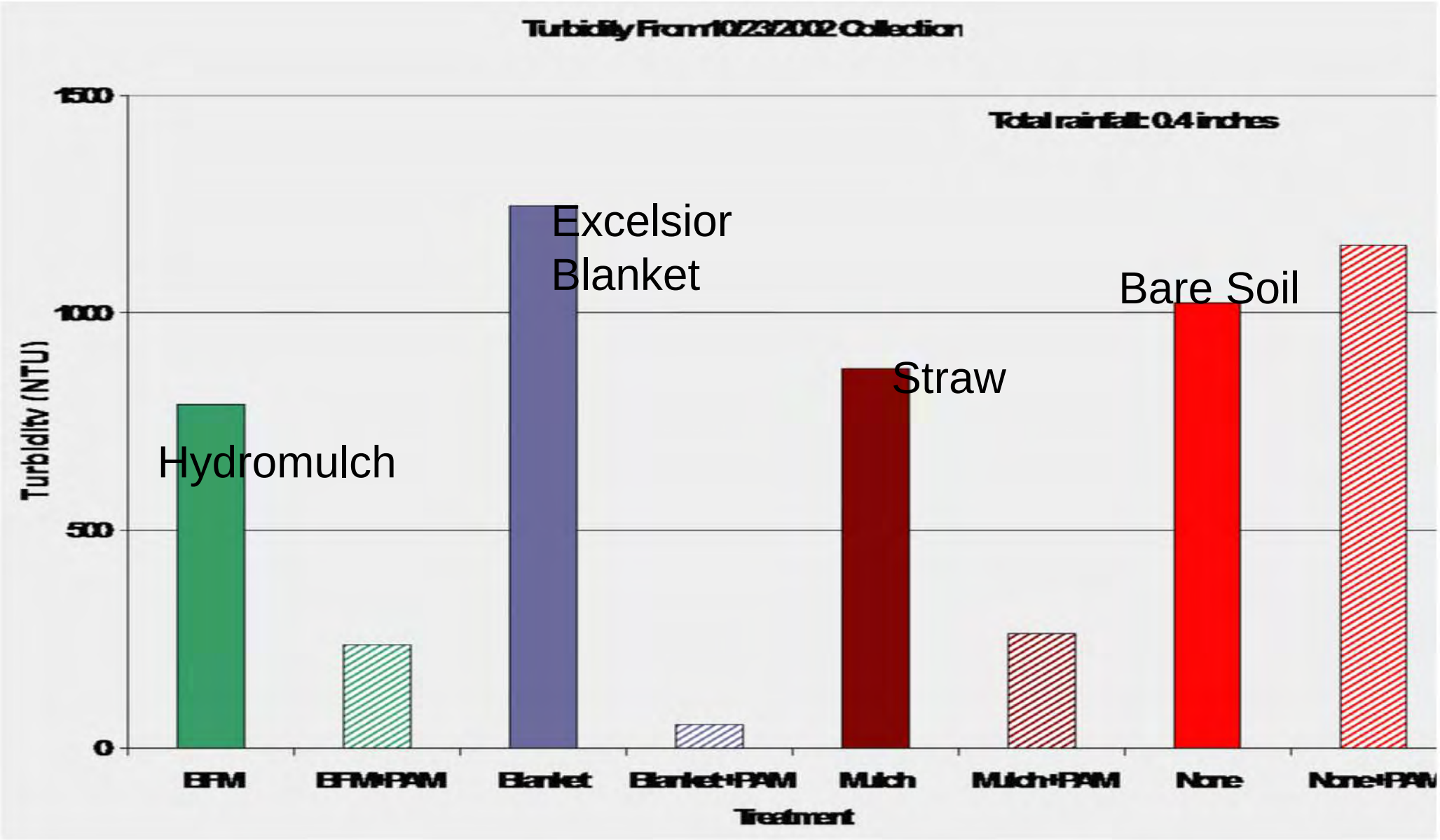
# Published Results

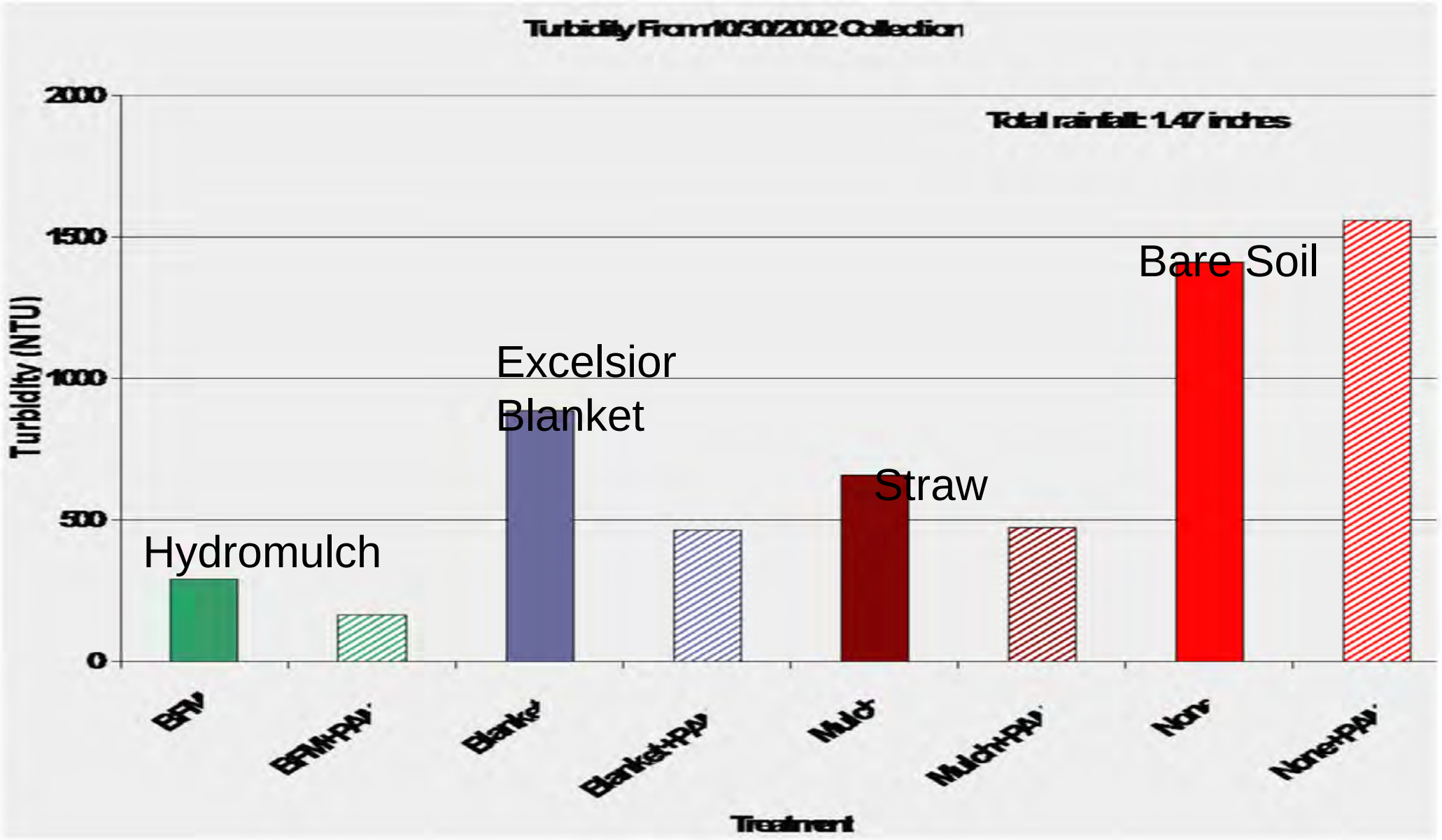
- PAM usually reduced erosion, but there appeared to be a minimum application rate for reliable results.
- PAM also usually reduced runoff volume, but there is some evidence that surface sealing can occur.
  - Depends on rate, concentration, and soil

# Many Tests Done...

# Turbidity — 1st Storm




Turbidity From 10/23/2002 Collection
Total rainfall: 0.4 inches
1500
1000
500
0
Turbidity (NTU)
Hydromulch
Excelsior Blanket
Straw
Bare Soil
BFM
BFM+PAM
Blanket
Blanket+PAM
Mulch
Mulch+PAM
None
None+PAM
Treatment

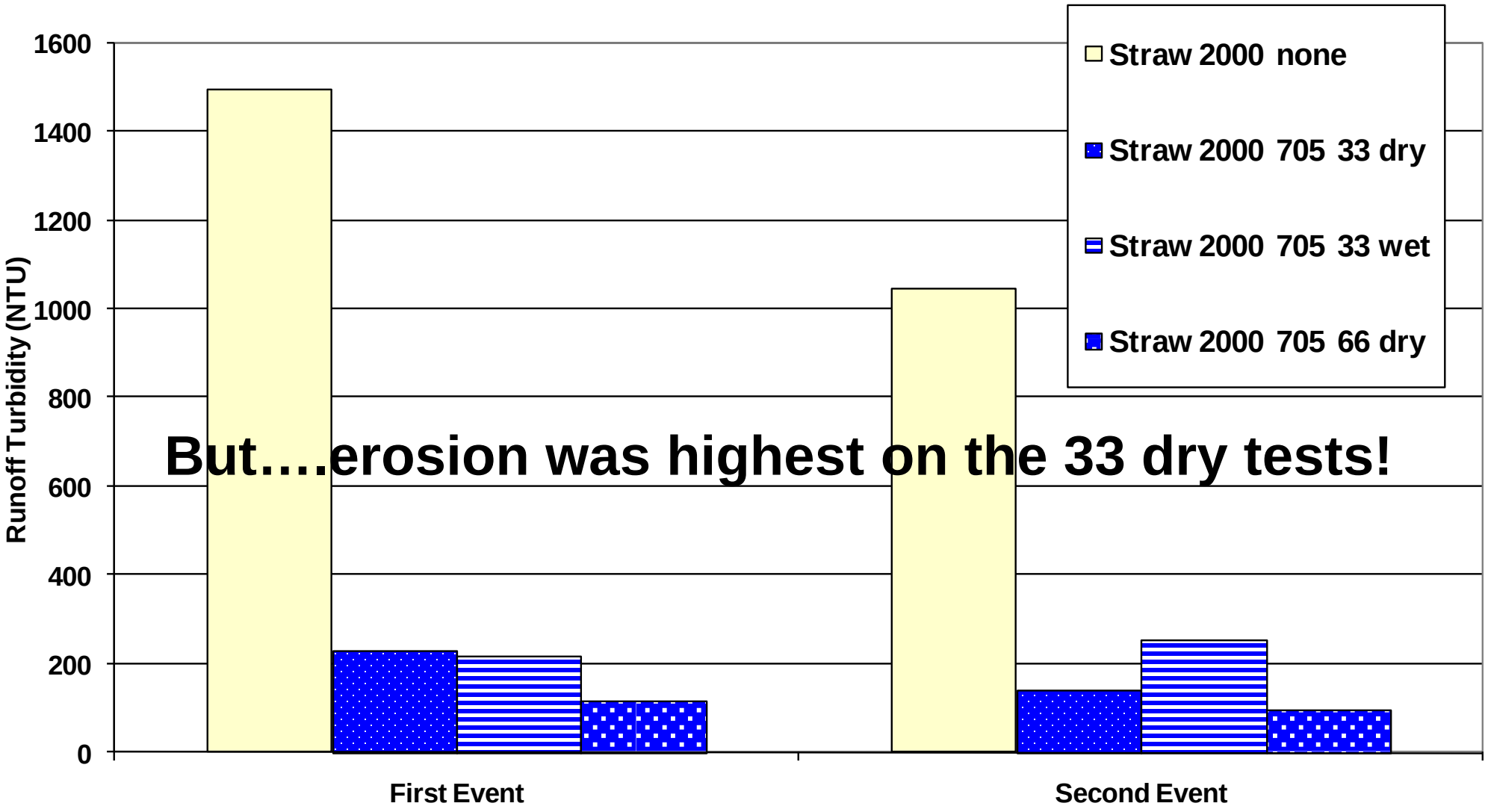

Turbidity From10302002 Collection
Total rainfall: 1.47 inches
Turbidity (NTU)
2000
1500
1000
500
0
Hydromulch
Excelsior Blanket
Straw
Bare Soil
Treatment

# Does PAM Reduce Erosion?

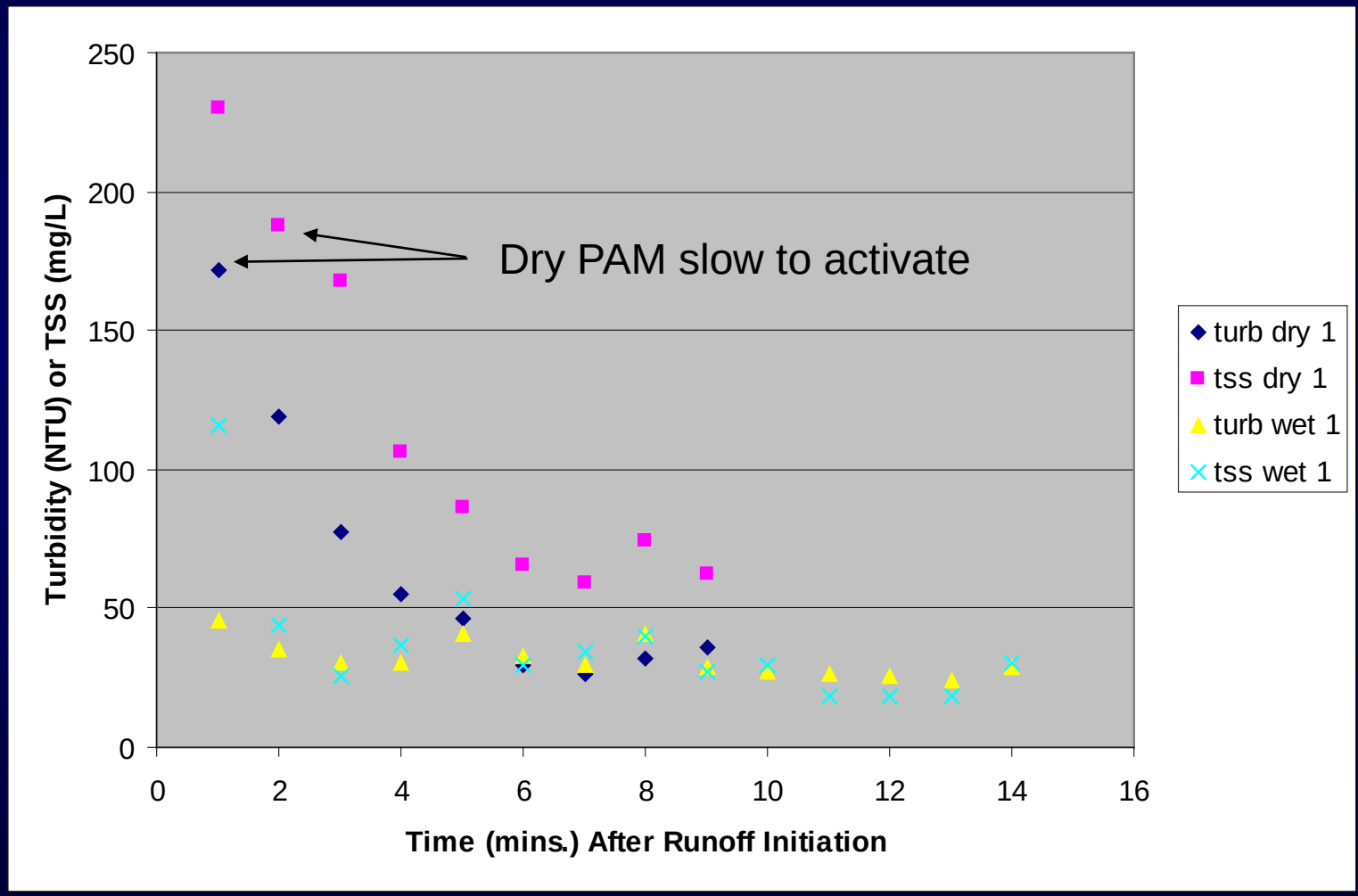
- Bare soil + PAM is still much worse than just ground cover.
- Less than 20 lb/acre is ineffective on steep slopes (3:1 or more).
- PAM effect longevity depends on conditions, but should get you to grass stage.

# Rainfall Simulator Results

# PAM: Granular vs. Solution



# Dry PAM Application Still Not Recommended



# Erosion Improvements

- Any ground cover is better than none (90% rule).
- Hydromulches and blankets may be more effective than straw.
- The application of PAM to bare soil is not a substitute for mulch.
- PAM application rates of **20 lb/acre** is needed to be effective.
- PAM may improve straw performance to hydromulch or blanket level.

# Careful with the PAM!

# Passive Dosing Approaches for PAM

Melanie McCaleb, MS, CPESC
Soil Science Department
NC State University

# Polyacrylamide (PAM)

Passive approach has benefits, just replace PAM from time to time (not TOTALLY maintenance free!)

- Check dams with dry granular PAM
- Other granular PAM uses
- Floc logs (in pipes and other structures)

Remember, PAM-treated water CANNOT be discharged directly off site!

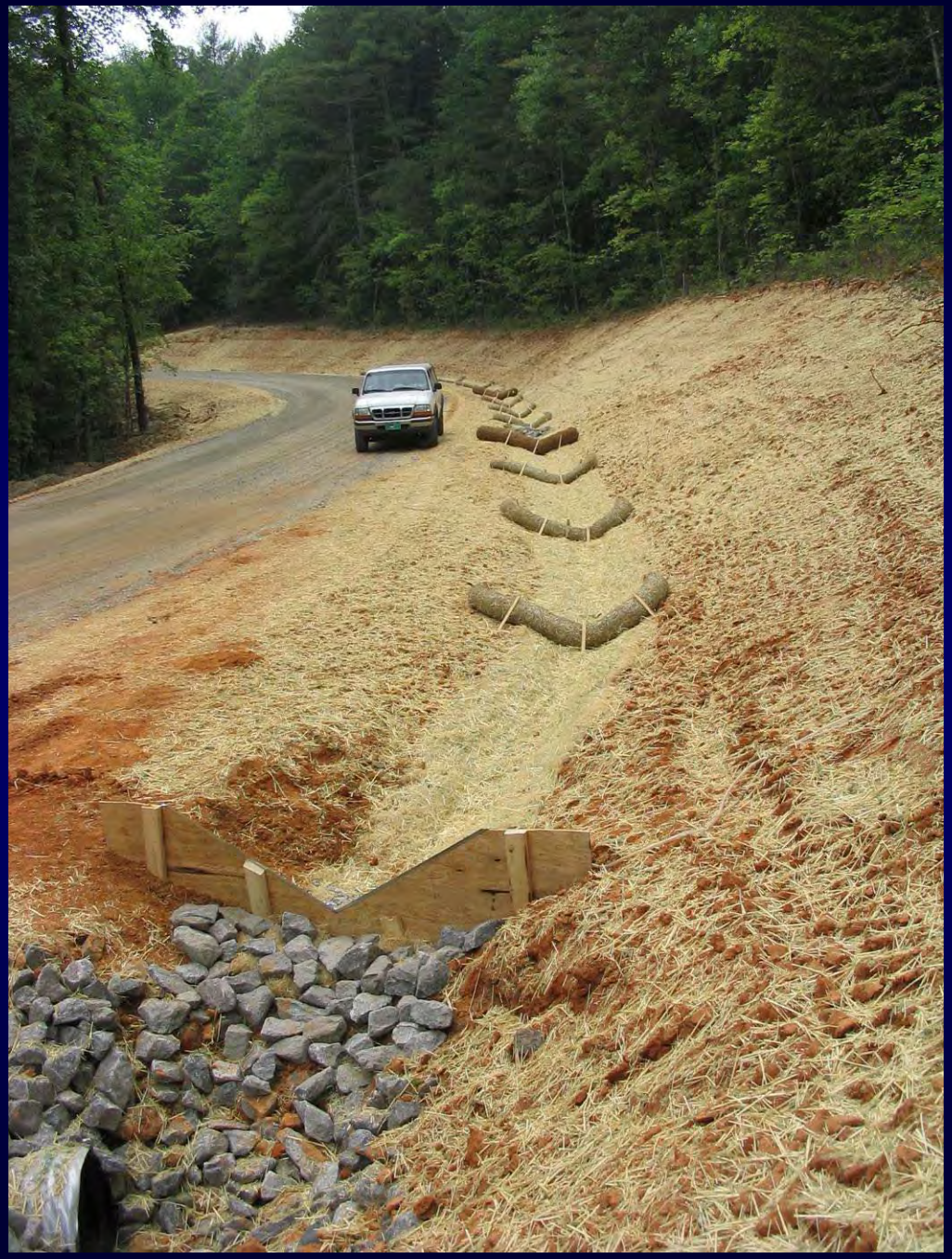
# EPA Rule: Toxicity Question

- While EPA recognizes that there is the potential for problems due to improper application of polymers, EPA has determined that when properly used, environmental impacts from polymers or flocculants should not occur through the use of passive treatment systems. The dose ranges where polymers are utilized on construction sites are well below the chronic toxicity levels.

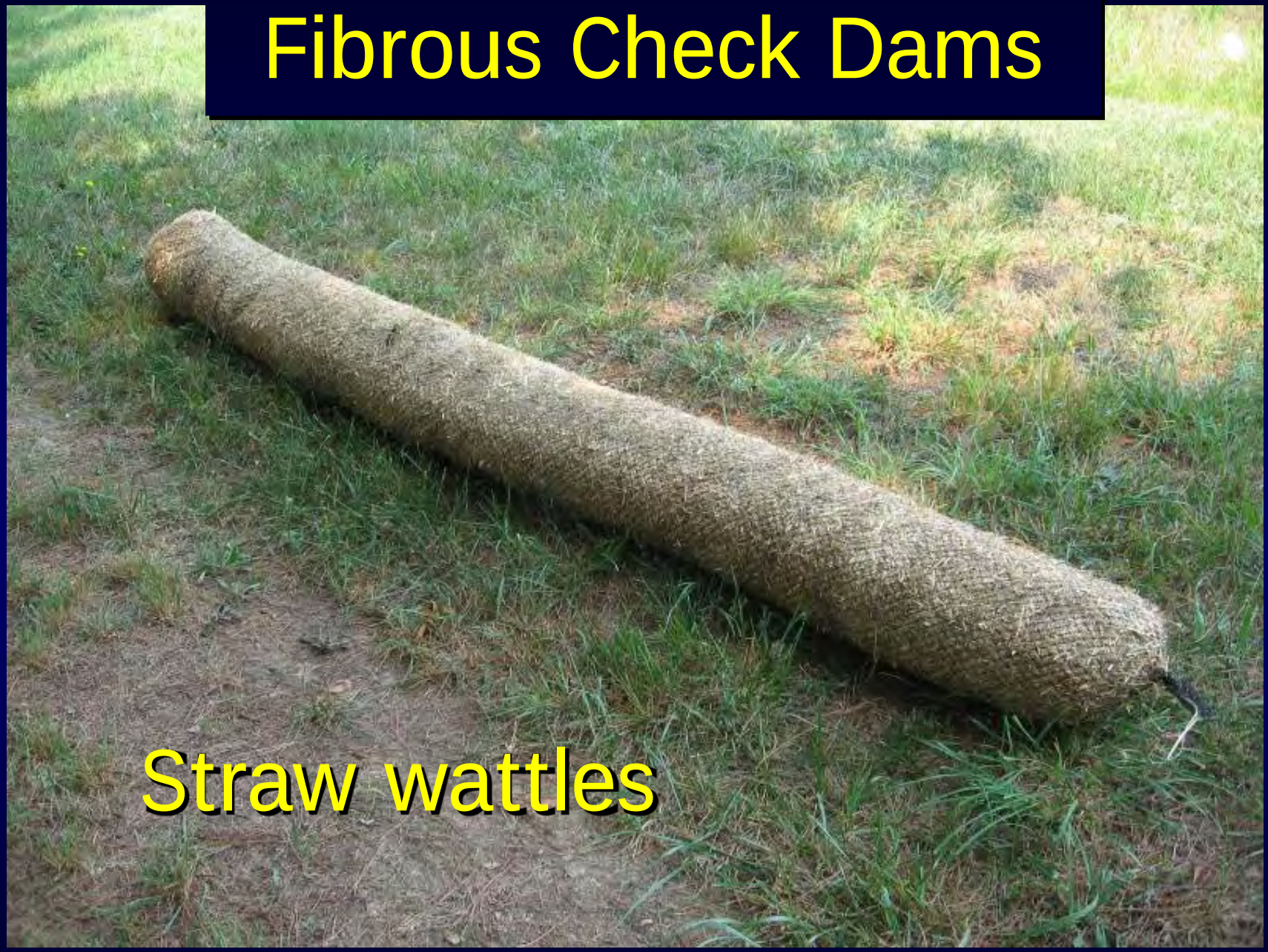
# Polyacrylamide (PAM)

- Forms: dry powder, logs, solution, emulsion


# Fibrous Check Dams with granular PAM

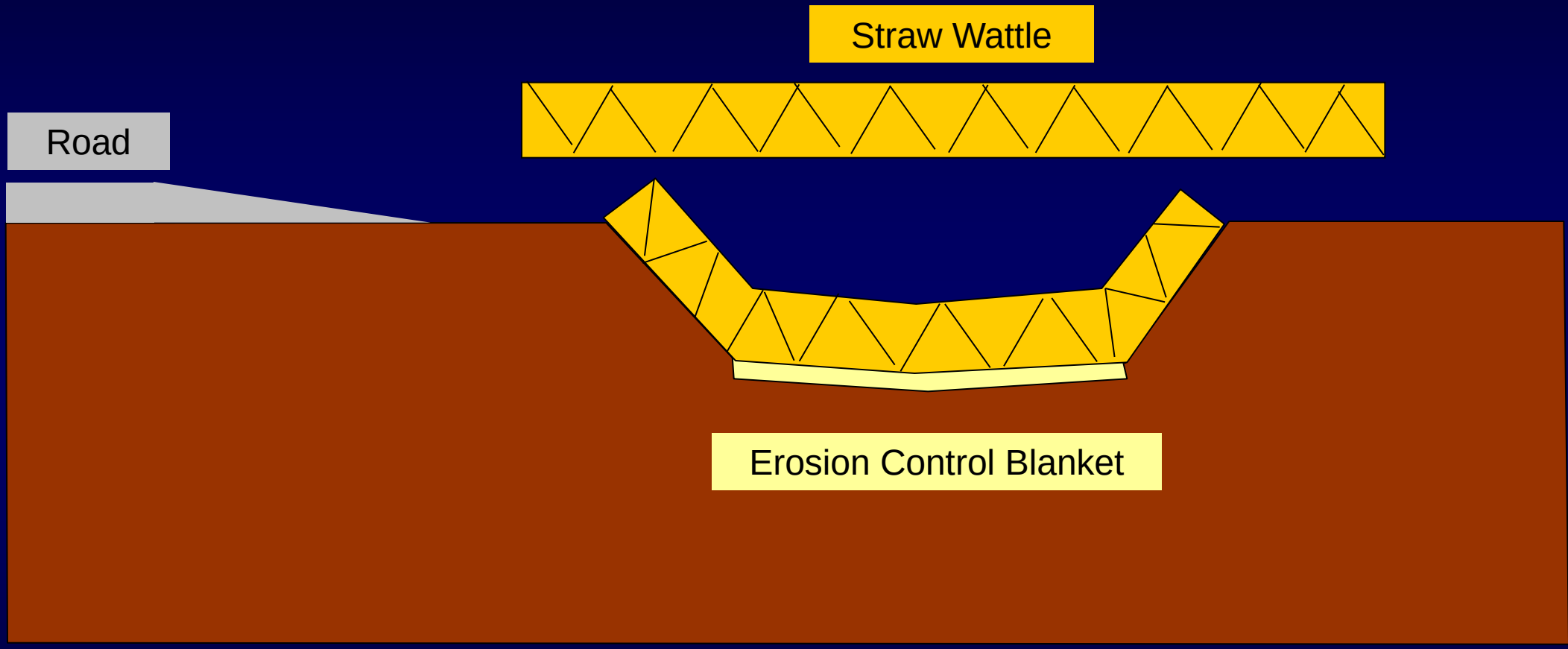


# Fibrous Check Dams

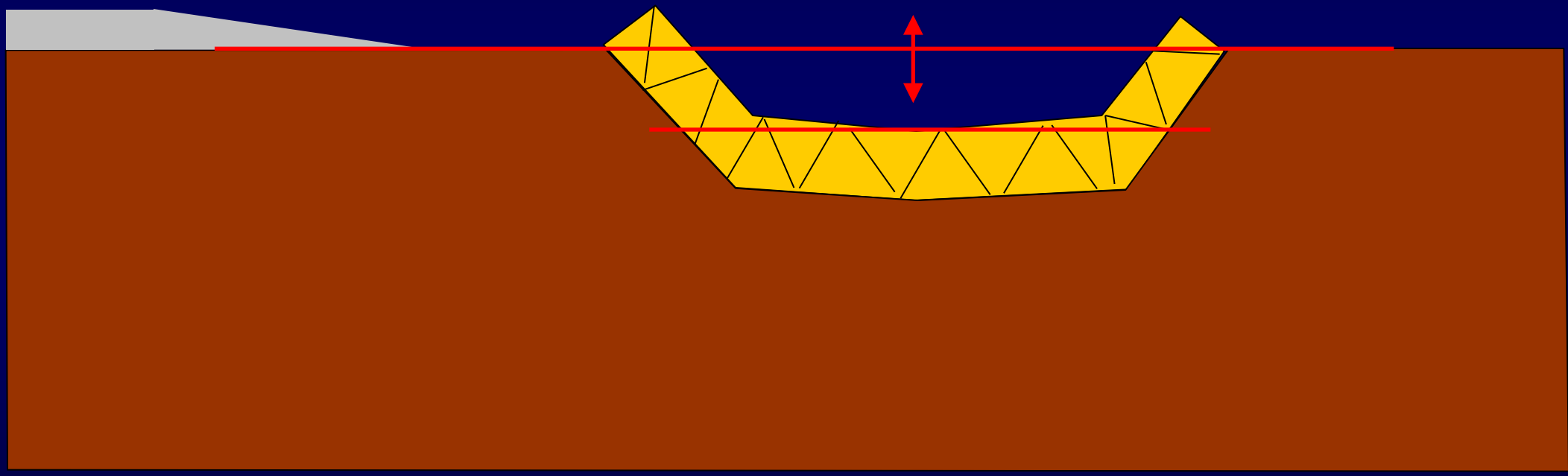


# Fibrous Check Dams

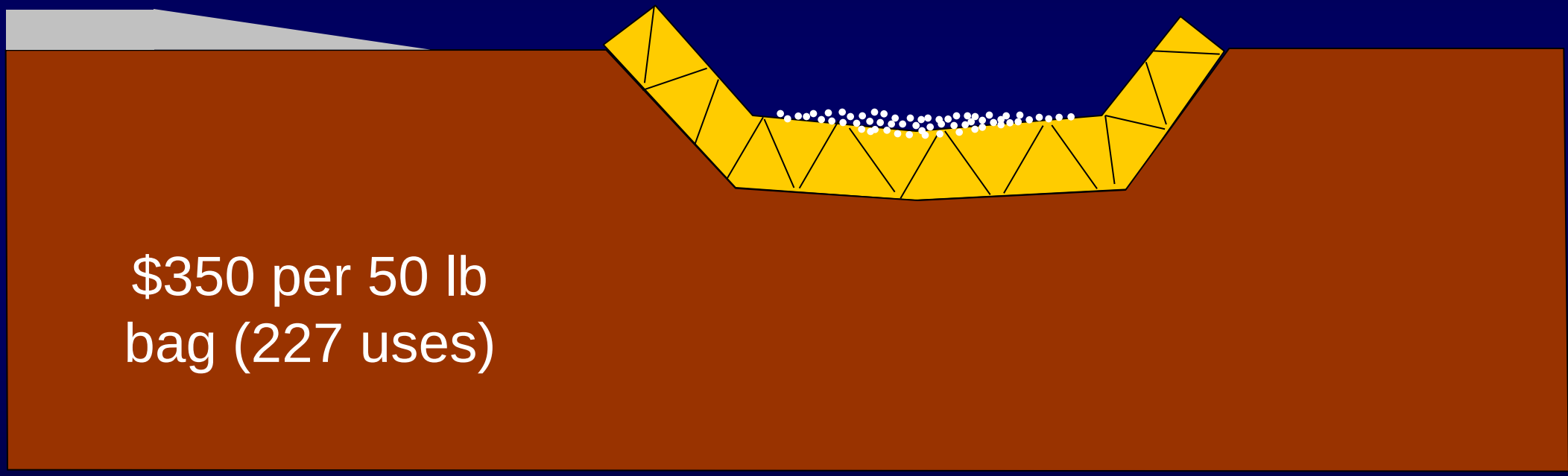
**The Basics: Simply fit the straw wattle across the ditch with some erosion control blanket beneath it.**



Important! Make sure the lower spill point of the wattles is below the height of the ditch sides so bypass flow does not occur.



**Sprinkle 100 grams of PAM over the lower center portion of the wattle where the water is going to flow over.**

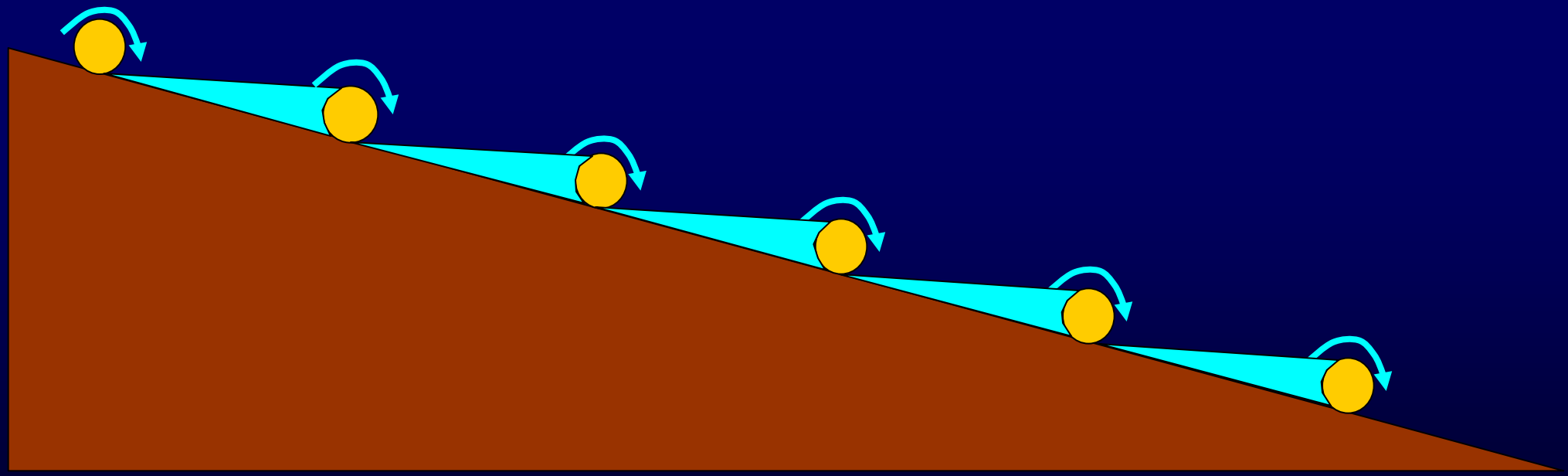


$350 per 50 lb bag (227 uses)

# Ideal BMP Spacing

- BMPs theoretically spaced such that flow goes from pool to pool…

This allows PAM mixing to occur and gives more time for sediment to fall out of suspension!




PAM mixing

**Sprinkle 100 grams of PAM 705 on the lower, center portion of the wattle where water is going to flow over.**

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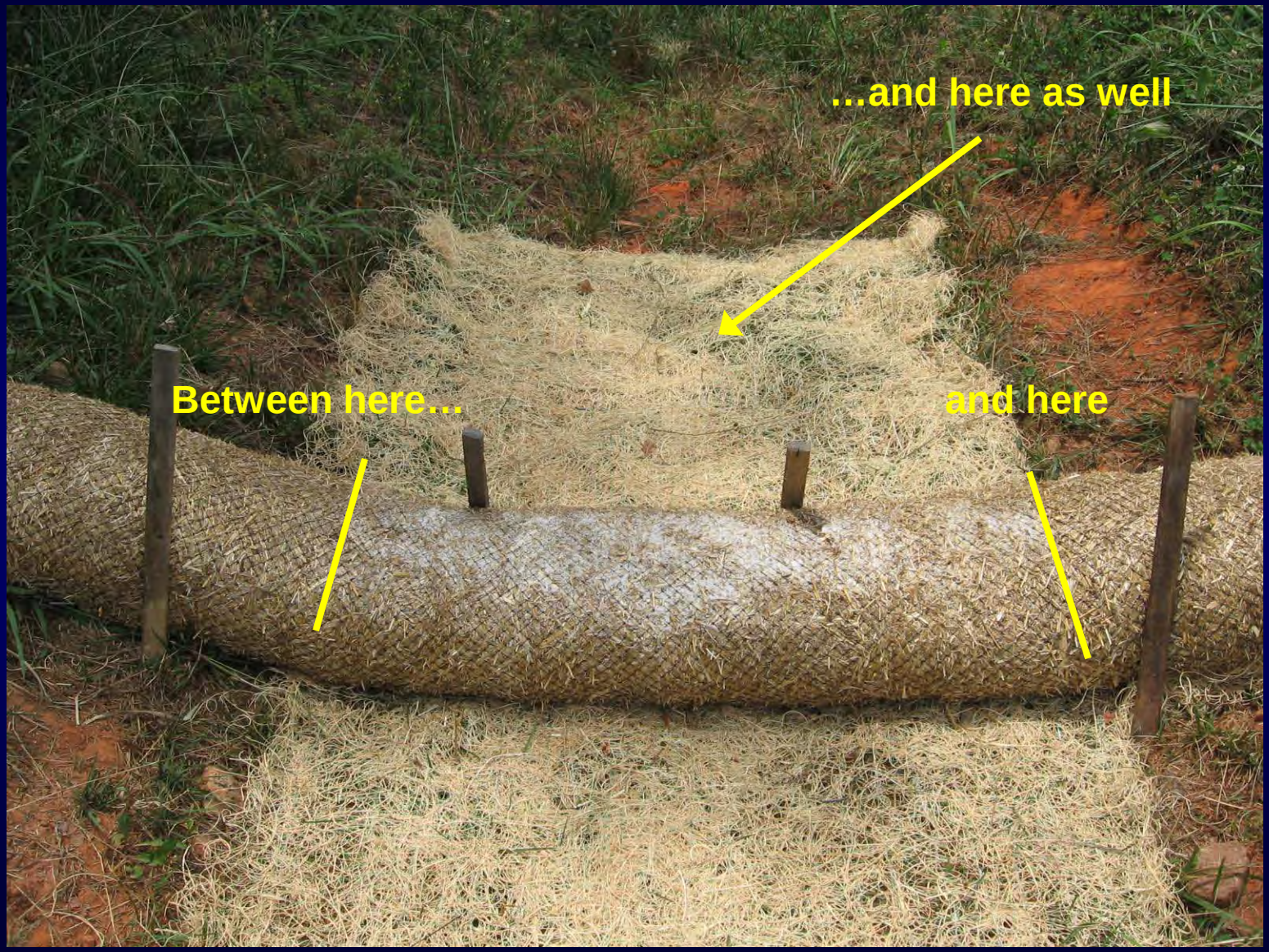
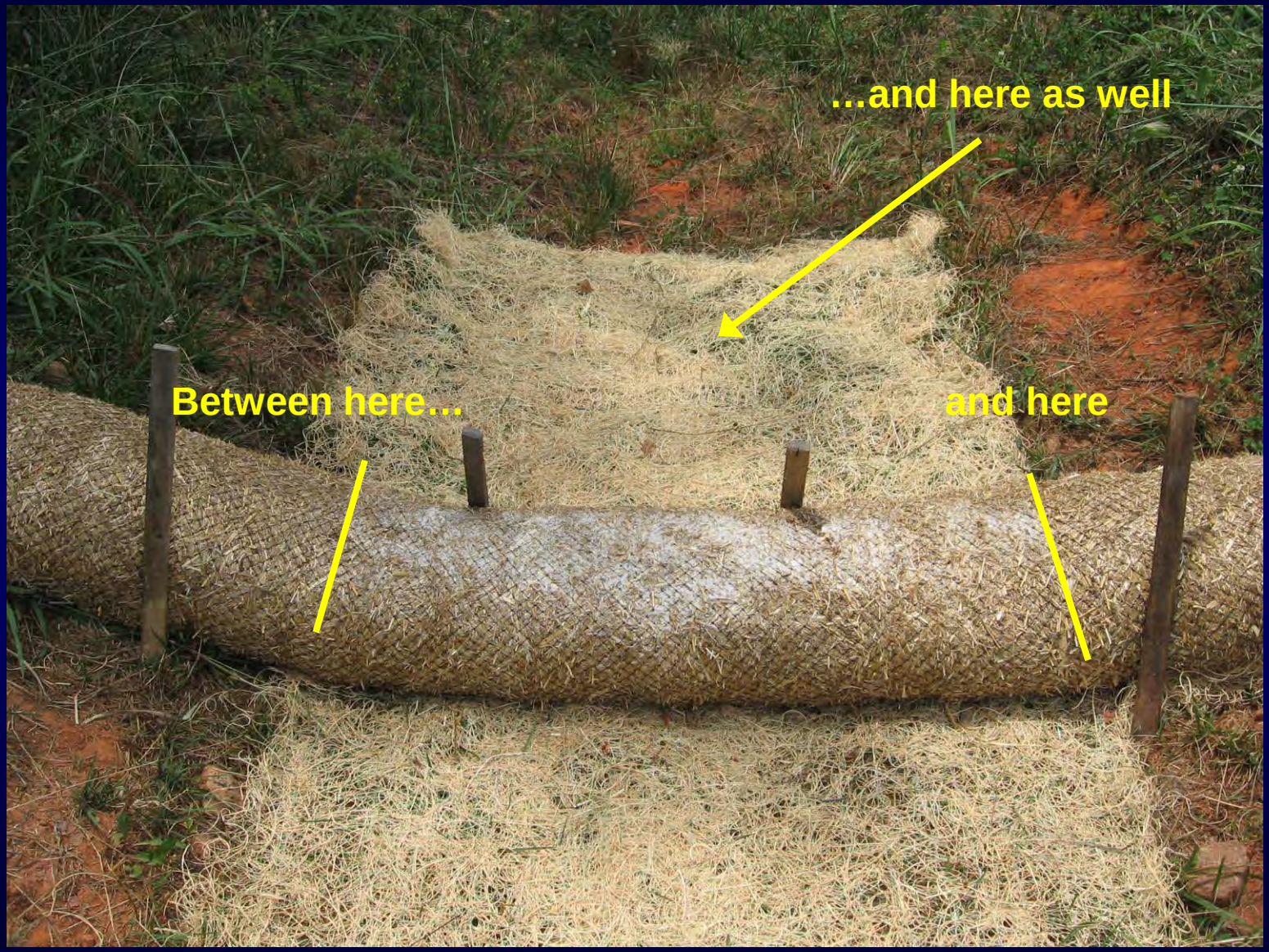
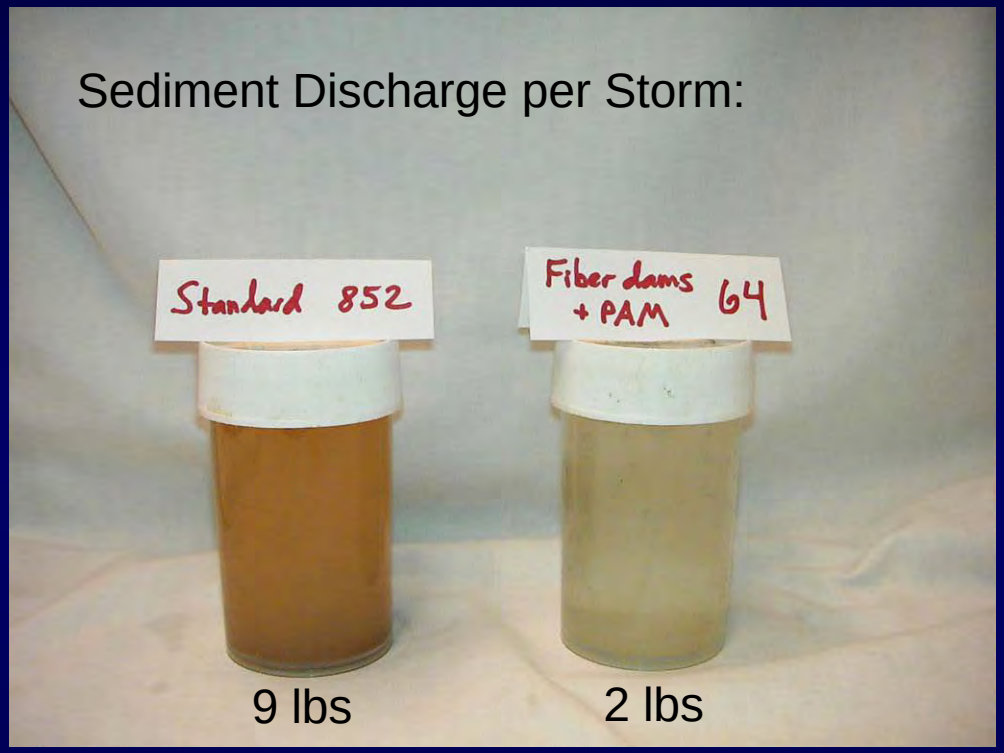
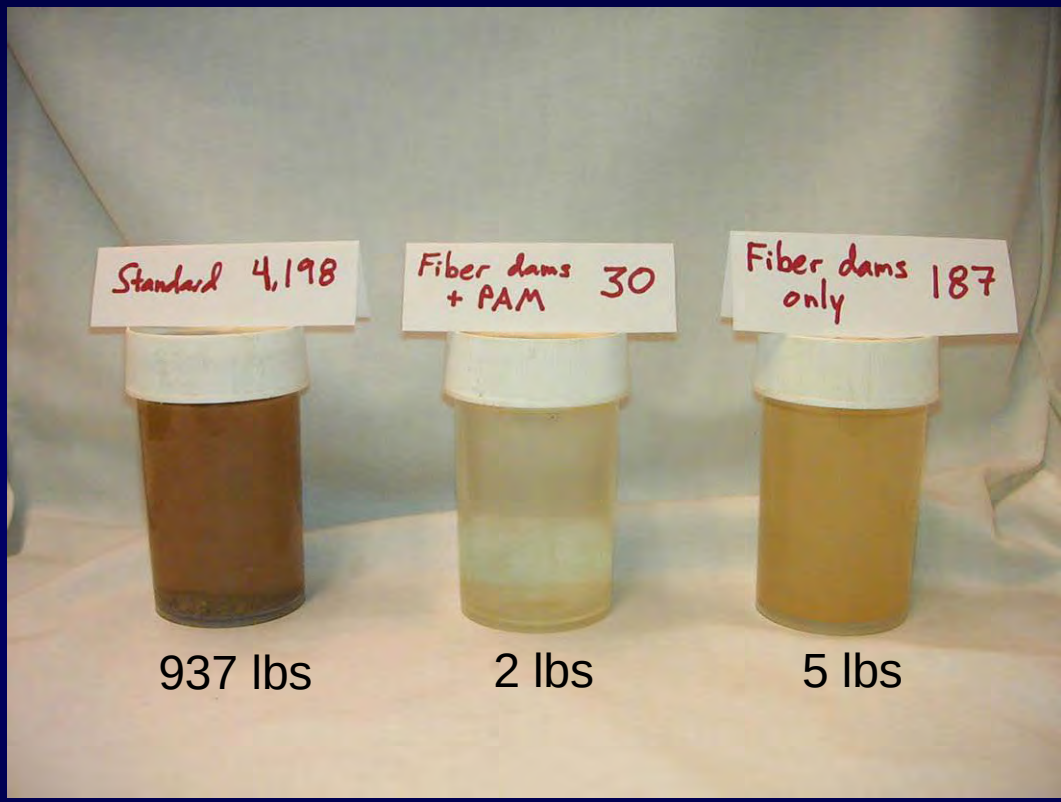


# Must replace with new PAM every so often as the weather dictates – Maintenance is always important!



# Very good results most of the time



# Cost Estimate Comparison

**Steeltown:**

| | |
|---|---|
| 450’ Standard section | $570 / $90 to maintain |
| 668’ Experimental BMPs + PAM | $734 / $41 to maintain |
| 461’ Experimental BMPs only | $1.41 / foot (spacing closer) |
| | $652 / no maintenance |
| | $1.26 / foot |

**Curley Maple:**

| | |
|---|---|
| | $1.10 / foot |
| 450’ Standard section | $570 / $90 to maintain |
| 668’ Experimental BMPs + PAM | $734 / $41 to maintain |

**The logs and wattles do not have to be removed either, they can decompose in place.**

soil

- 4 minutes at each 0.5, 1.0, 2.0, 1.0, and 0.5 cfs
- soil added at 6,000 mg/L
- 4 samples were collected in each bottle- 5 bottles total
- 3 consecutive runs
- sediment depth and length was measured
- LIDAR scan was taken


Rock


Rock w/ coir

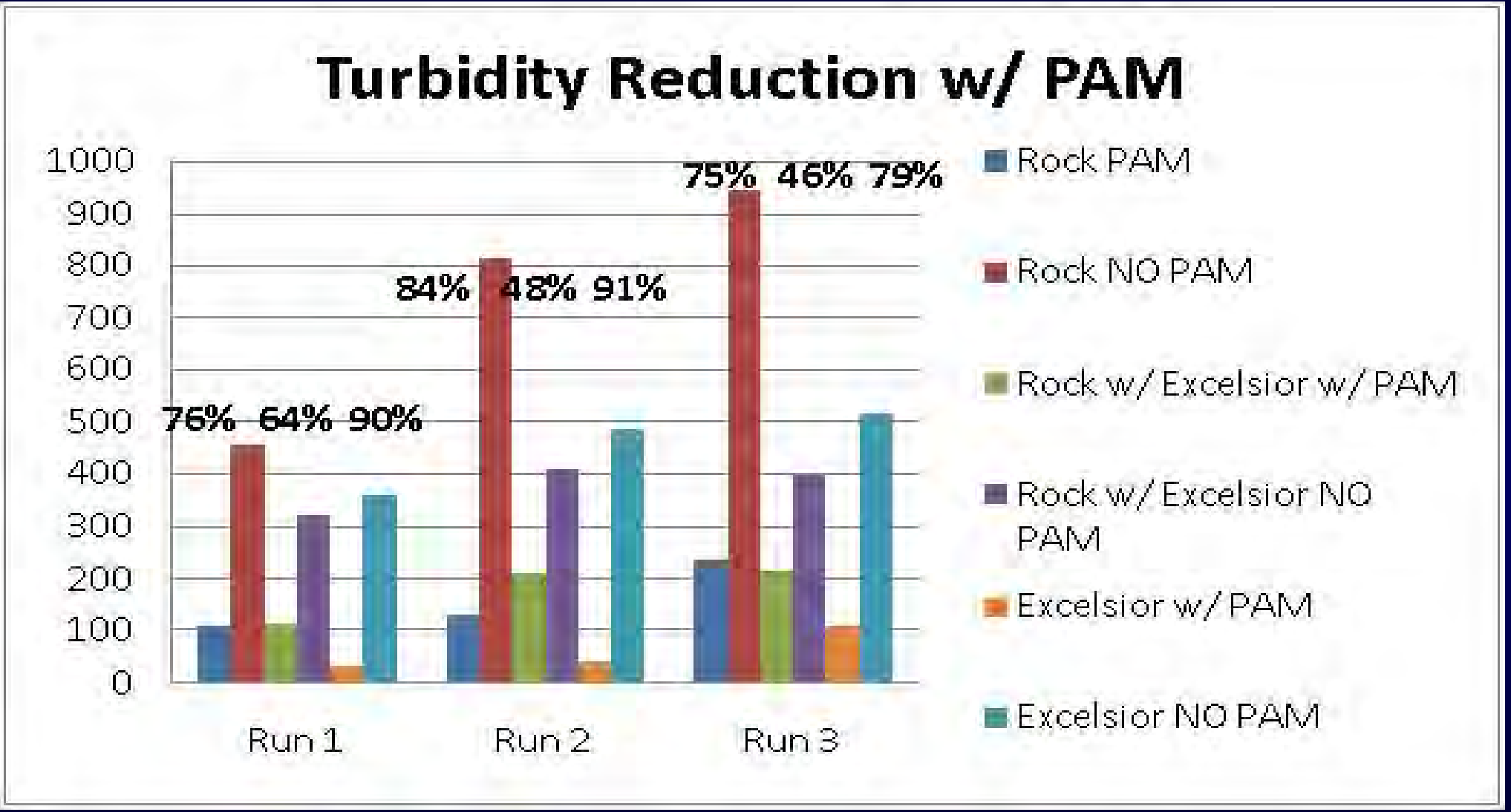

Coir logs


Excelsior wattles


Rock w/ Excelsior


Flocs sticking to rocks

# Comparison of Treatments



# Wattle Theft!

# Animal Damage!

# Other Options for Check Dams

Rock checks only (no basins)

# Other Options for Check Dams

# Other Options for Check Dams

## Triangular Silt Dike™

# Removing Flocs From Flow: Options

- Discharge into a basin or trap
- Leave last several check dams untreated
- Level spreaders

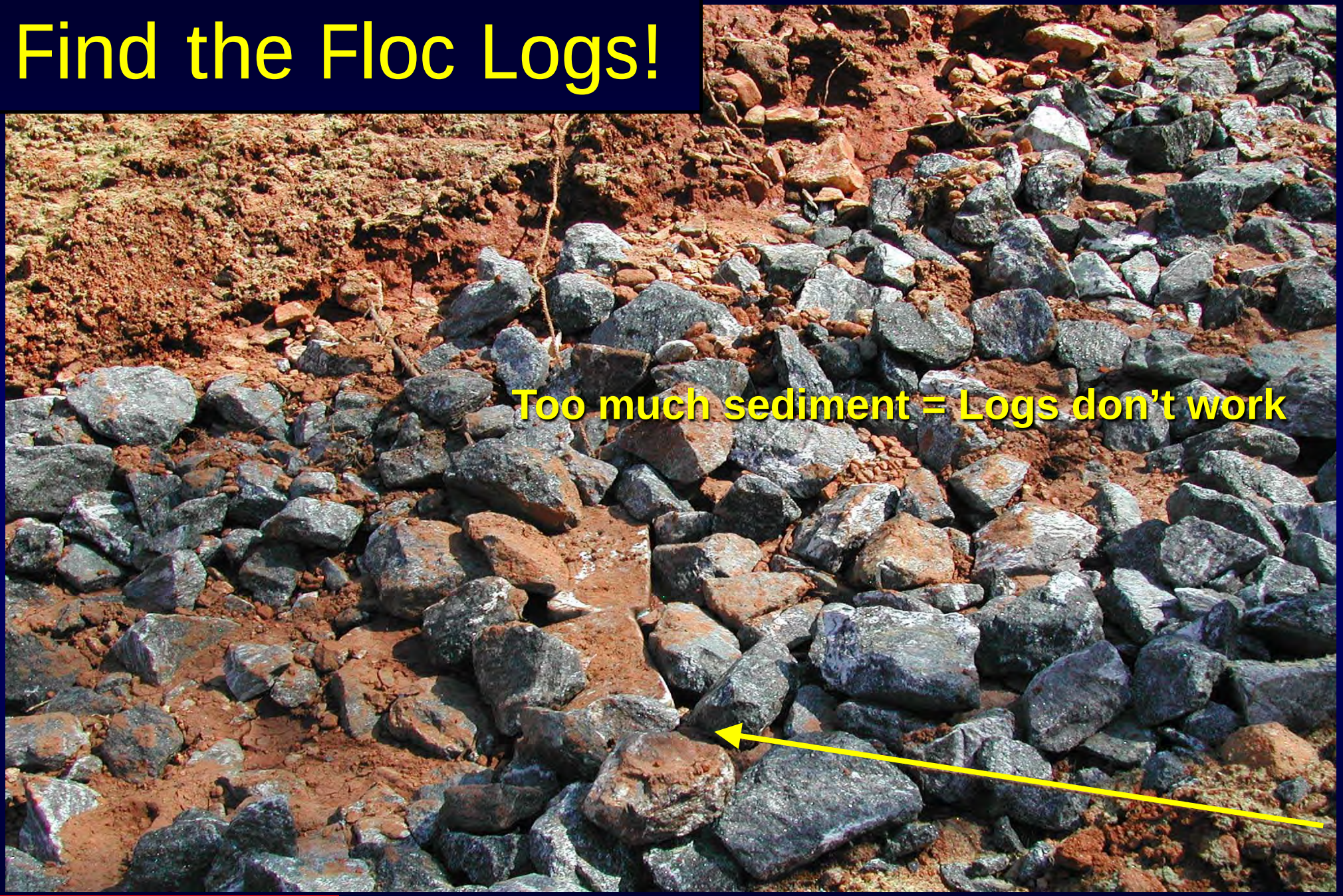
# Other Passive Approaches using Granular PAM

PAM sprinkled on coir baffle in basin (maybe)

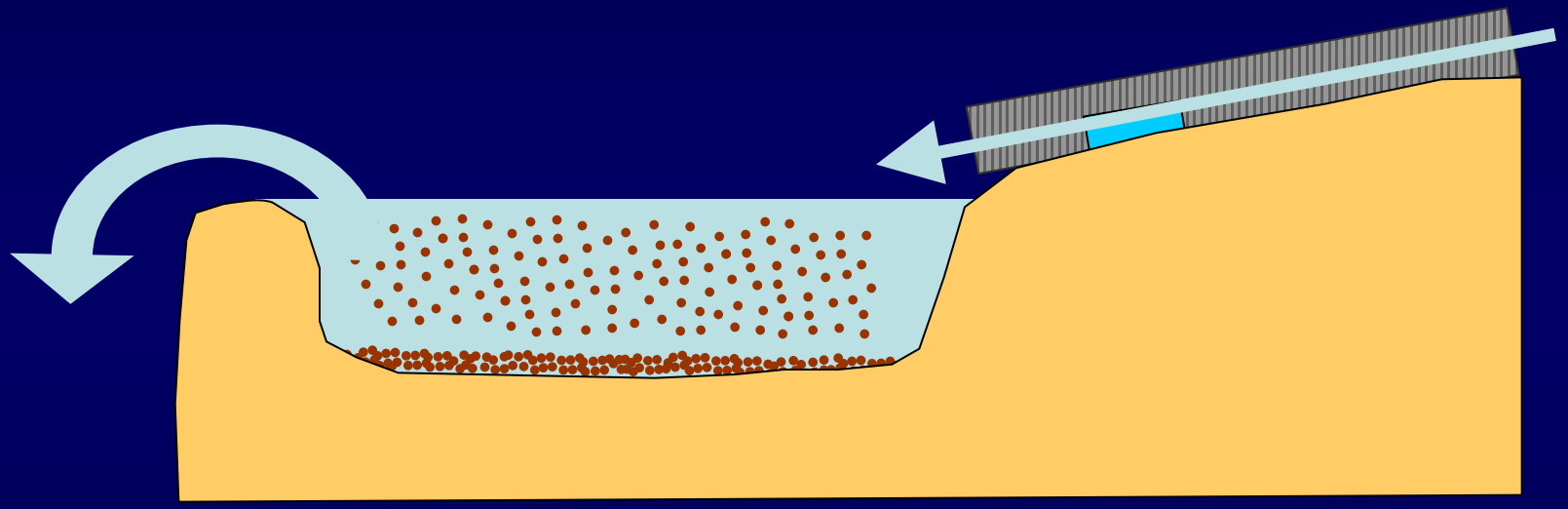
PAM sprinkled on erosion control matting down a slope

# Solid PAM Blocks (Floc Logs™)

# Find the Floc Logs!



# Place PAM logs inside pipes



Discharge into basin/trap
before discharging off site!

# Passive Dosing with PAM in Pipes

# PAM in Pipe

# Two Chamber Basin Design



**4,000 – 5,000 NTU observed elsewhere**

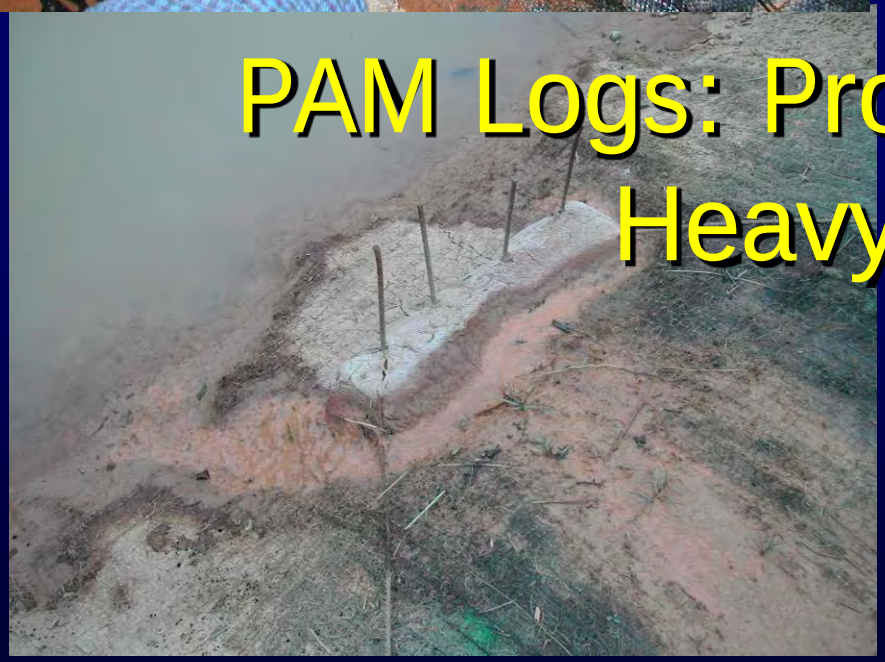
# Pipes w/ Logs in Ditches

**Basins below had very clear water**

# PAM Bucket?

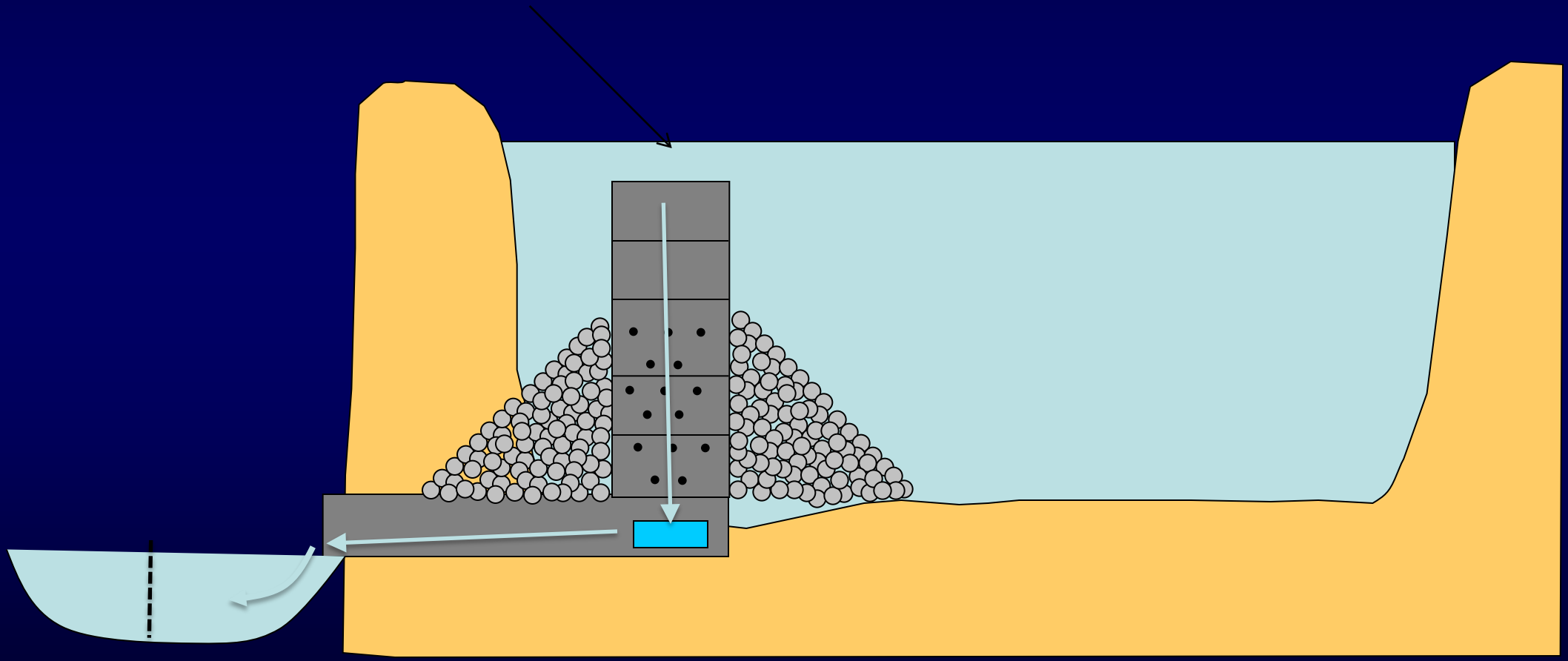
Not so much…

# PAM Log Failures?



# PAM Logs: Protect From Sun and Heavy Sediment!

# Riser Barrel – great log location... but need settling/filtration afterward



# Riser Barrel – great log location...

**…but remember that you need to settle/filter afterward!**

# Drop Inlets – Another Good Option for PAM Logs

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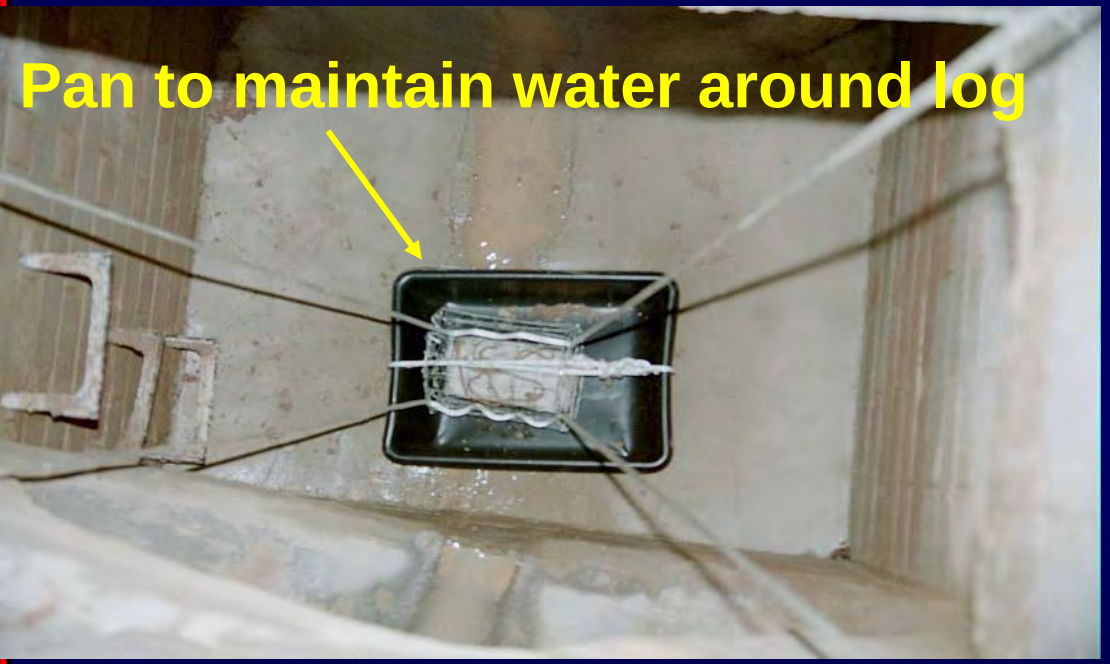
**No berm so substantial bypass observed during heavy storms**

# Drop Inlets – Another Good Option for PAM Logs

# PAM log in storm drain




# Stabilized Ditches

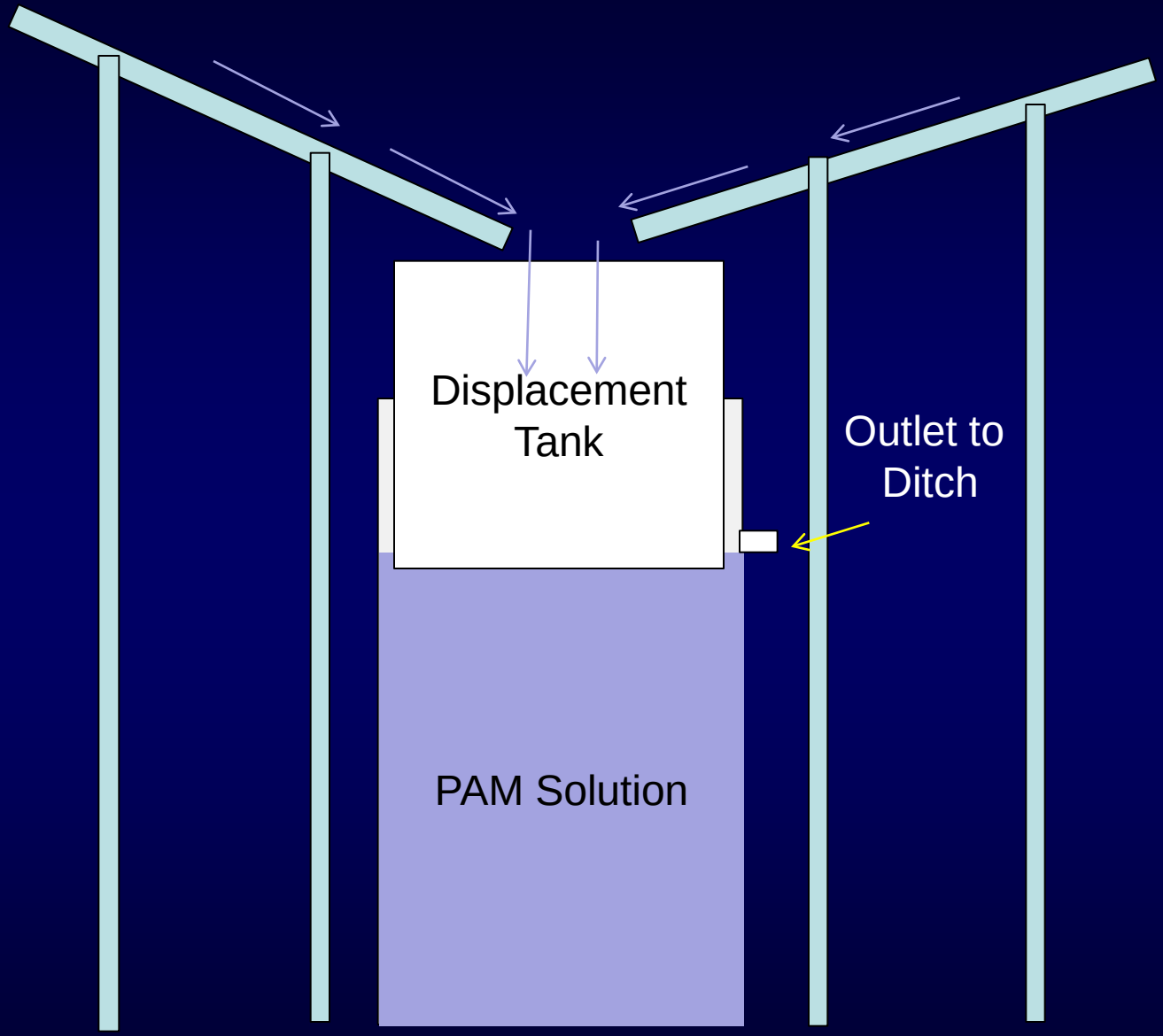
- Check dams (some with PAM)
- Jute ditch lining
- Basin (with baffles and skimmer)

# Improvise As Needed

# Follow The Water

# Rain-Driven Liquid Doser

- Created in New Zealand
- Doses runoff with solution of coagulant or flocculant using rainfall


Displacement Tank
Outlet to Ditch
PAM Solution

# Keys to Making PAM Logs/Powder Work for You

- Match PAM to your soil or suspended sediment and water chemistry.
- Reduce sediment load prior to PAM treatment.
- Keep the PAM moist.
- Create high flow onto PAM.
- Create high mixing (turbulence) after PAM.
- Allow for settling post-treatment.


Any Questions?

# Active Treatment Systems

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# Pumped Construction Site Water

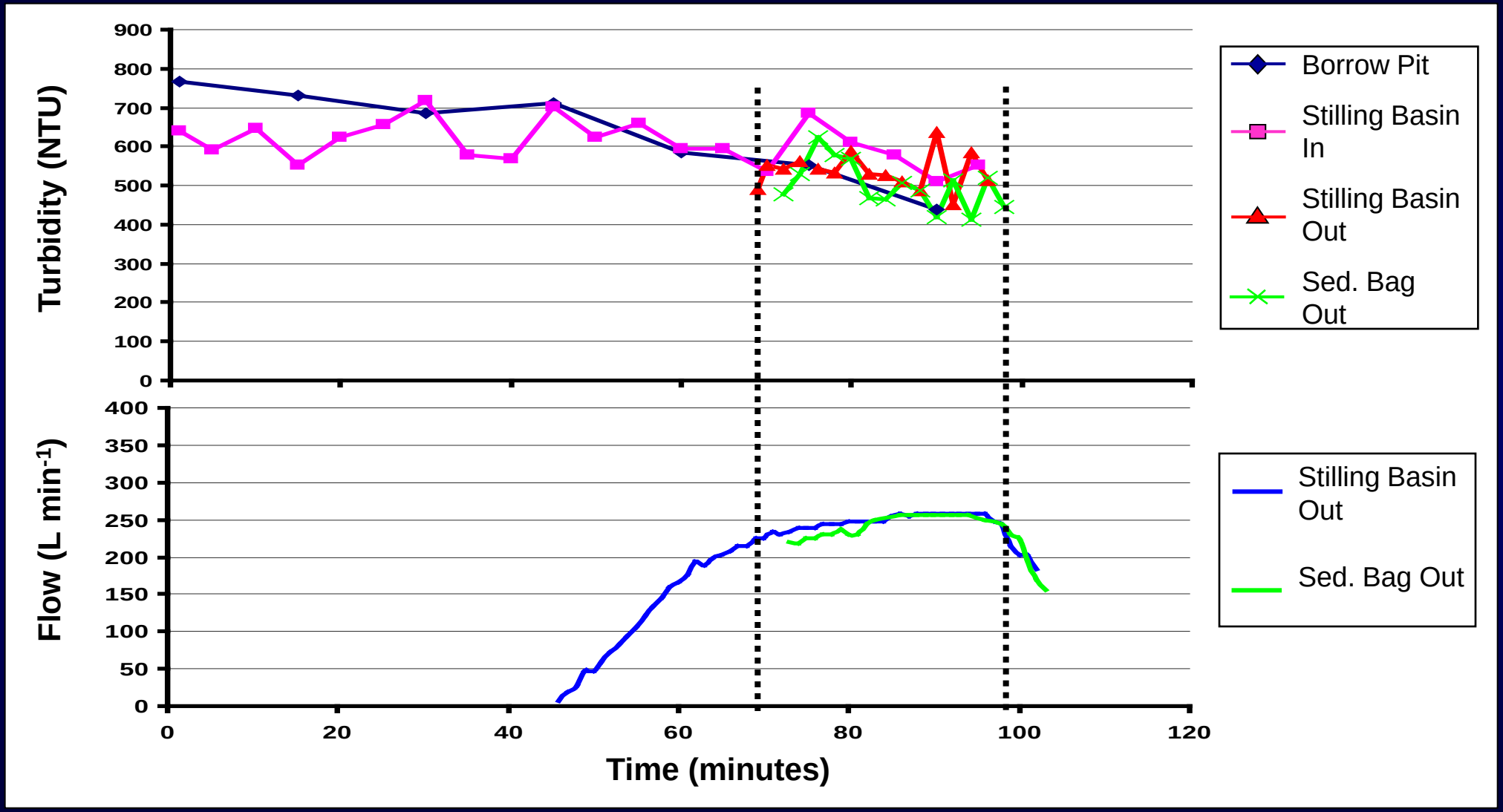
# Borrow Pits: Sometimes Turbid

# Field Testing: Generate Turbid Water

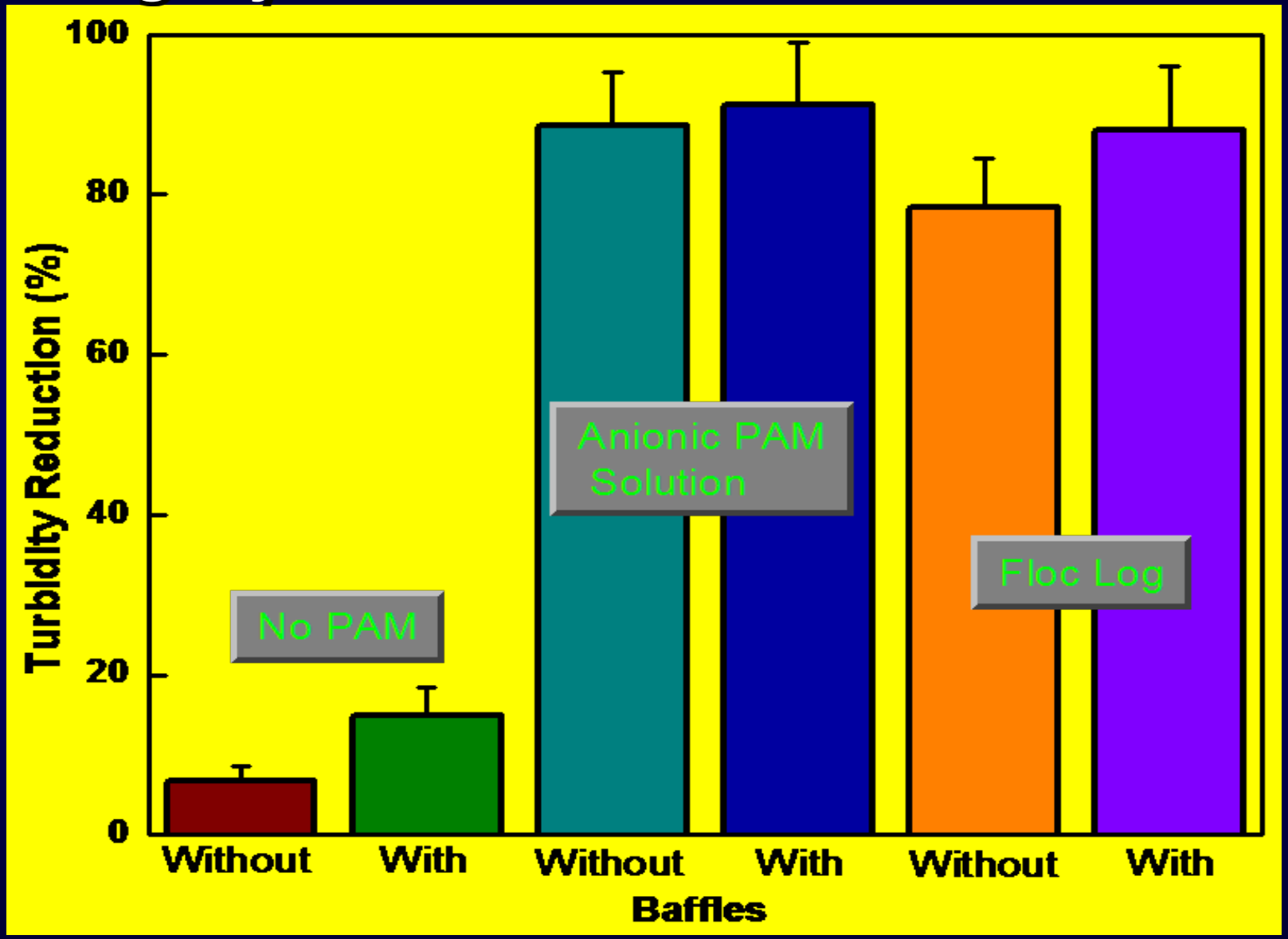
# Pump to Stilling Basin

# Basin Design Treatments in Stilling Basin

# No PAM

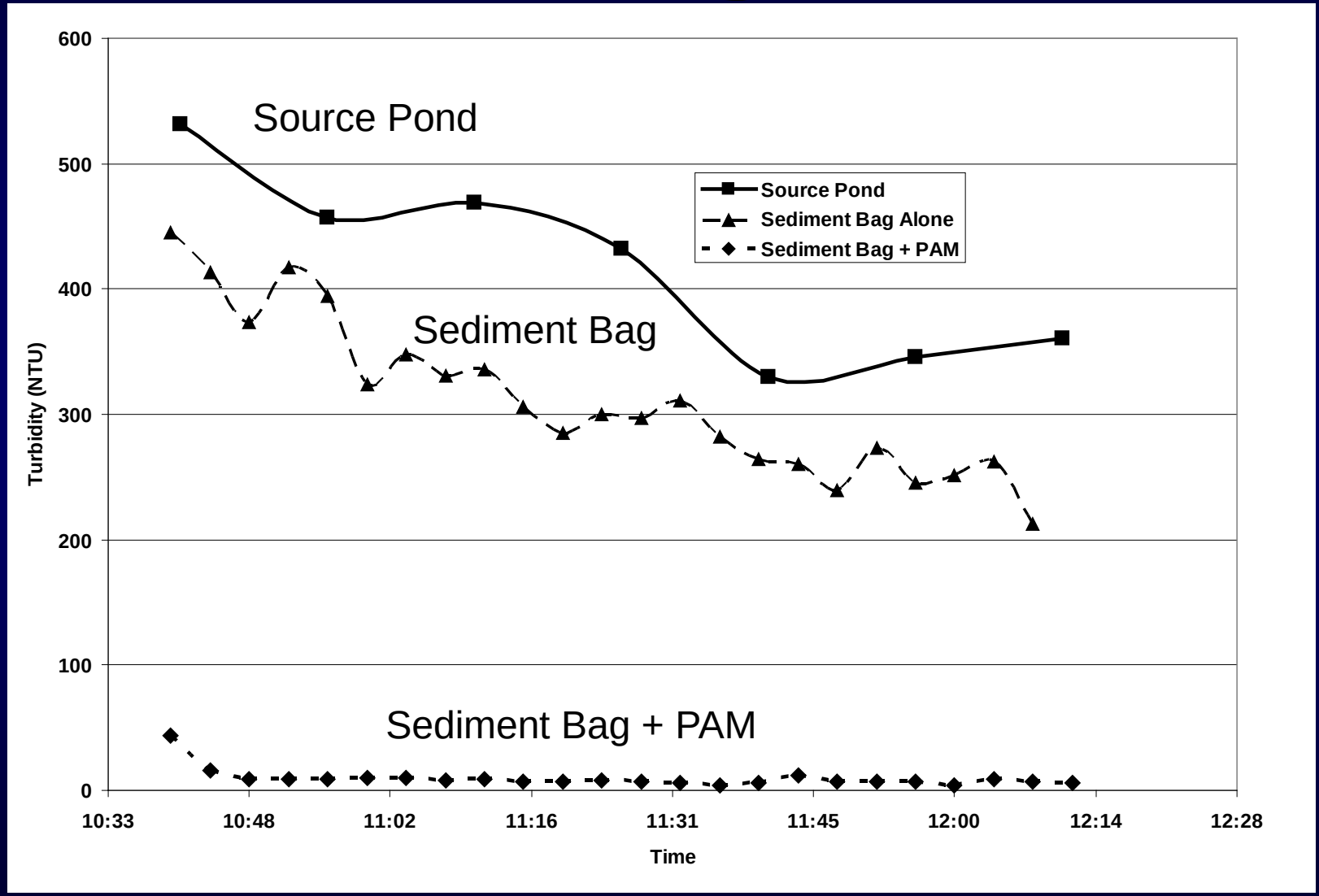

Turbidity (NTU)
900
800
700
600
500
400
300
200
100
0
Borrow Pit
Stilling Basin In
Stilling Basin Out
Sed. Bag Out
Flow (L min-1)
400
350
300
250
200
150
100
50
0
Stilling Basin Out
Sed. Bag Out
0
20
40
60
80
100
120
Time (minutes)

# Dosing System: Solution vs. Solid Block

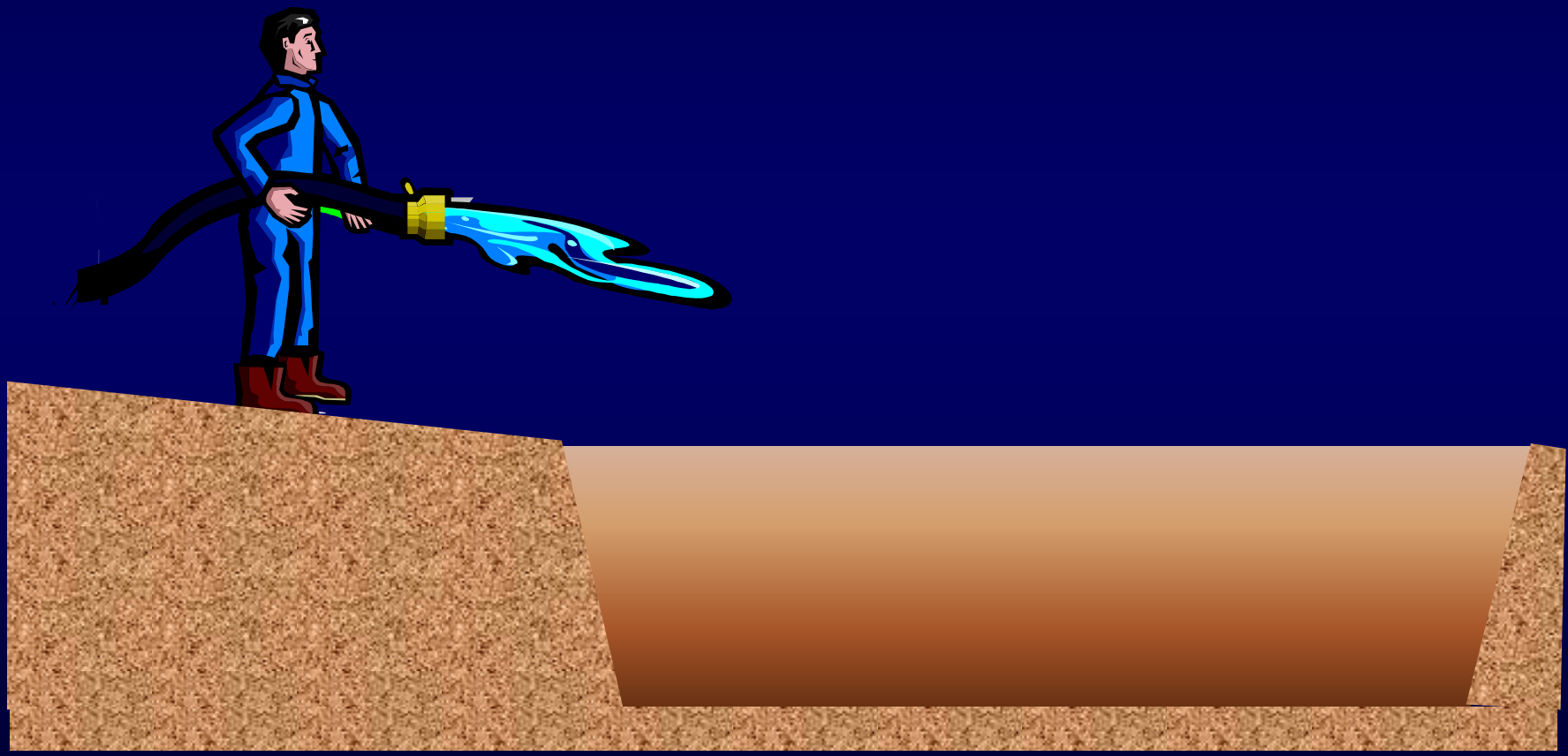


# Sediment Bags and PAM?

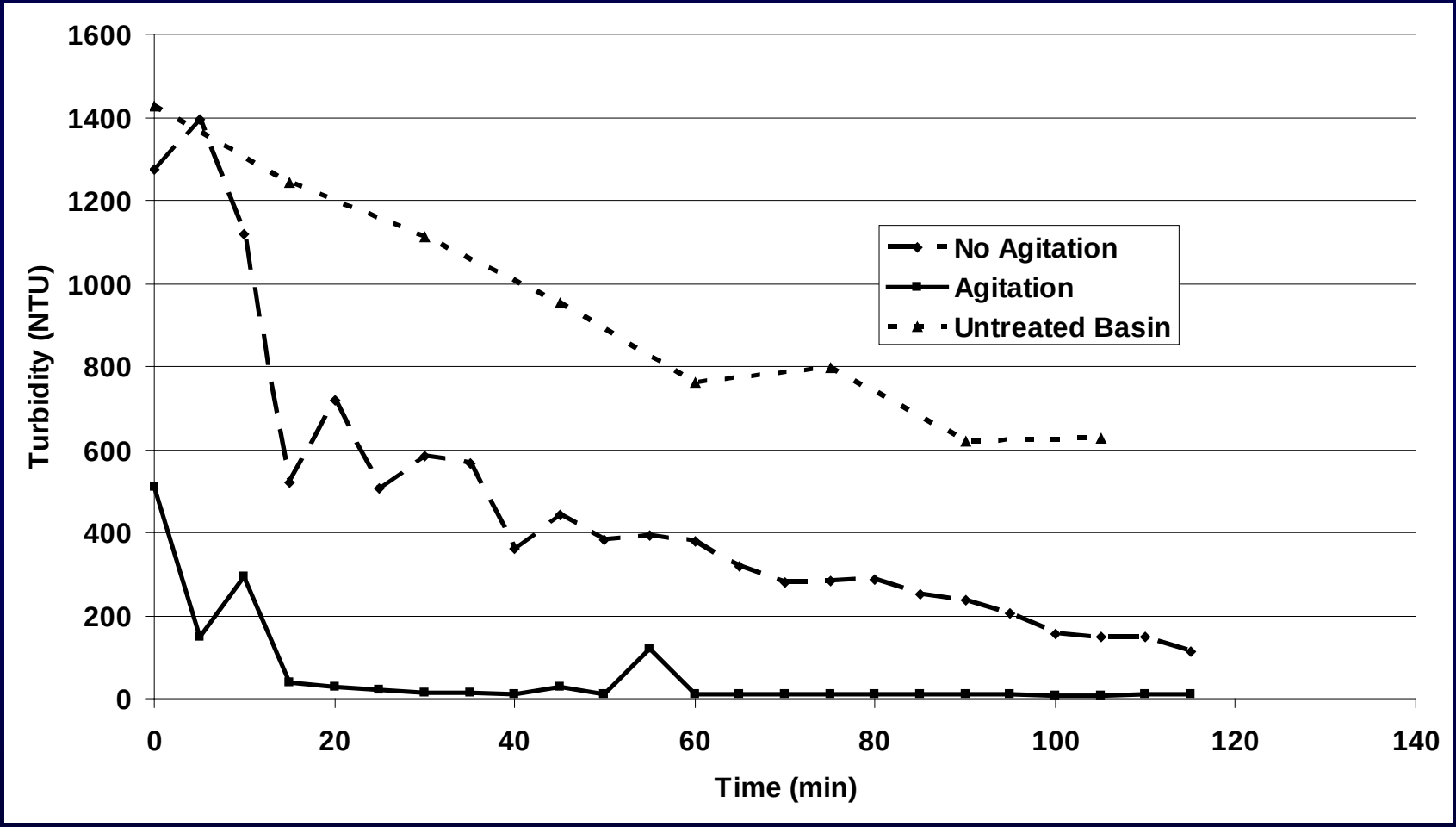
# Sediment Bag and PAM



# Surface PAM Solution Application?

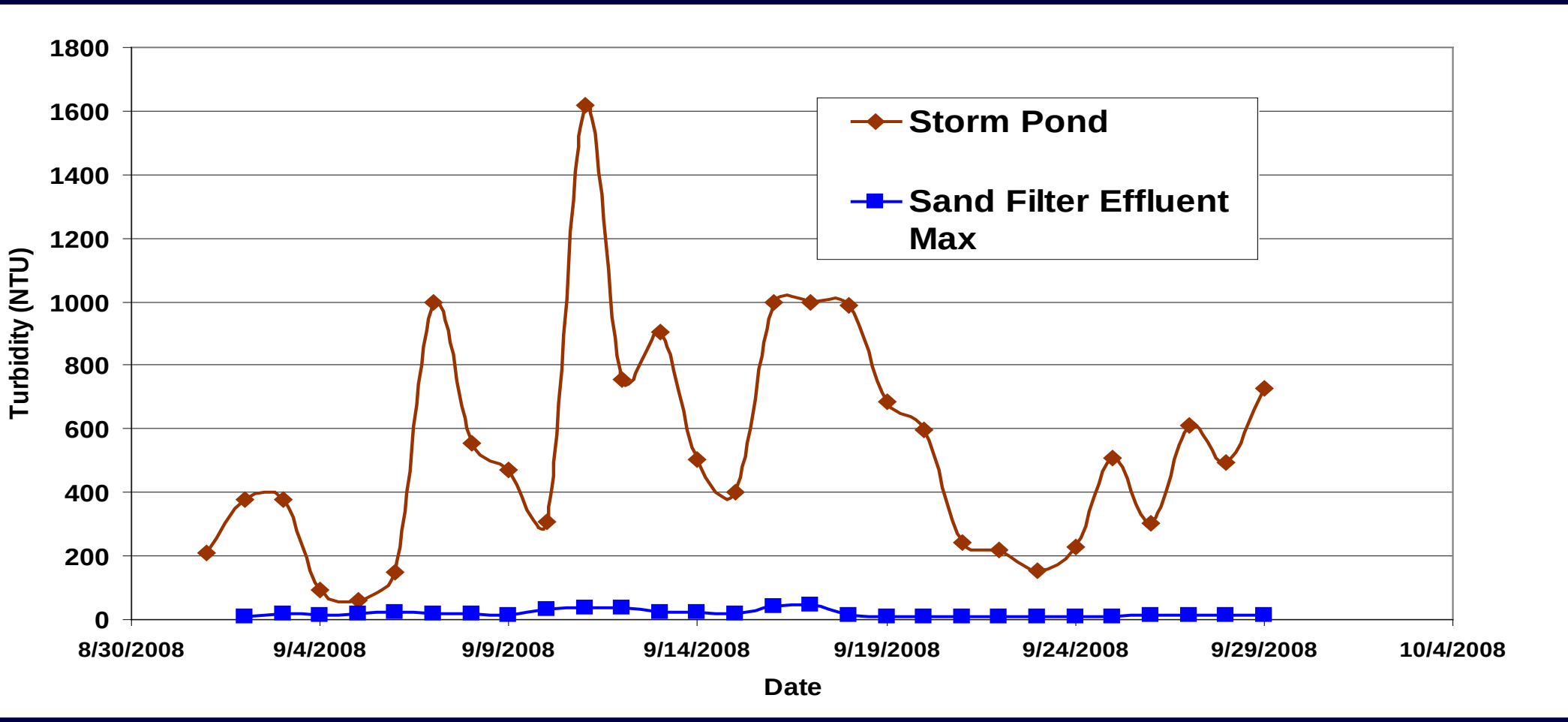


# Actual Test Results



# Active Treatment Option: West Coast System

# Active Treatment: Durham




Receiving Stream Turbidity Was Actually Reduced!

# Treat an Acre Inch?

27,000 gal x 3.8 L/gal = 103,000 L

# Passive Dosing at Peak Flow

- Q (peak flow) = C (runoff coef.)*I (rainfall intensity)*A (area), in CFS
- See spreadsheet to determine peak flow

# Peak Flow Dosing

14 cfs = (7.5 gal/cf)x(3.8 L/gal)x14
=399 L per second

399 L/s x 60 sec/min x 5 min
= 120,000 L for 5 min

1 mg/L = 120,000 mg, or
120 g, or 0.26 lb

# Pump Dosing Rates

- Desired concentration is 1 mg/L
- Stock solution is 0.5 g/L
- Calculate for 100 and 1000 gpm rates

# Pumping

Pump Rate:  100 gpm = 380 Lpm;

Concentrate: 0.5 g PAM/L=500 mg PAM/L

How much for 1,000 gpm pump rate?