EVALUATION OF EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES: USE OF SILT FENCE TIEBACK SYSTEMS AND ANIONIC POLYACRYLAMIDE ON HIGHWAY CONSTRUCTION SITES

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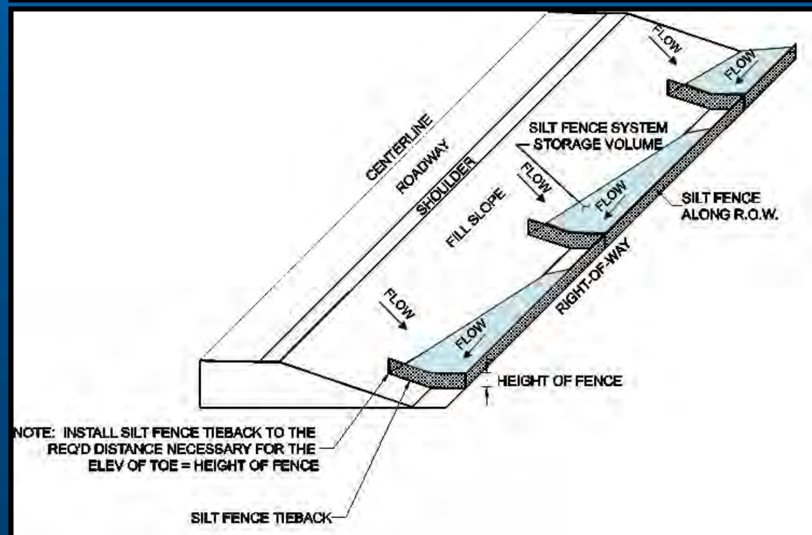
Presentation Outline

- Design of Silt Fence Tieback (a.k.a. "j-hook") Systems for Sediment Control
- Silt Fence Tieback Conclusions
- Intermediate-Scale Erosion Control Experiments Using Anionic Polyacrylamide (PAM)
- PAM Conclusions

Silt Fence Tieback Systems

- Silt Fence Tieback (a.k.a. “j-hook”) Systems
  - Created by turning the downslope end of the linear silt fence back into the fill slope
  - Prevents stormwater runoff from passing around the toe of the fence
  - Forces flow through the fence at the bottom of the fill slope
  - Serve as temporary detention basins to allow suspended sediment to settle out of suspension



Silt Fence Tieback Design Tool

- Stormwater Runoff Volume Component
  - Computes the stormwater runoff volume generated by a user defined rainfall event using the Soil Conservation Service (SCS) Curve Number (CN) method.

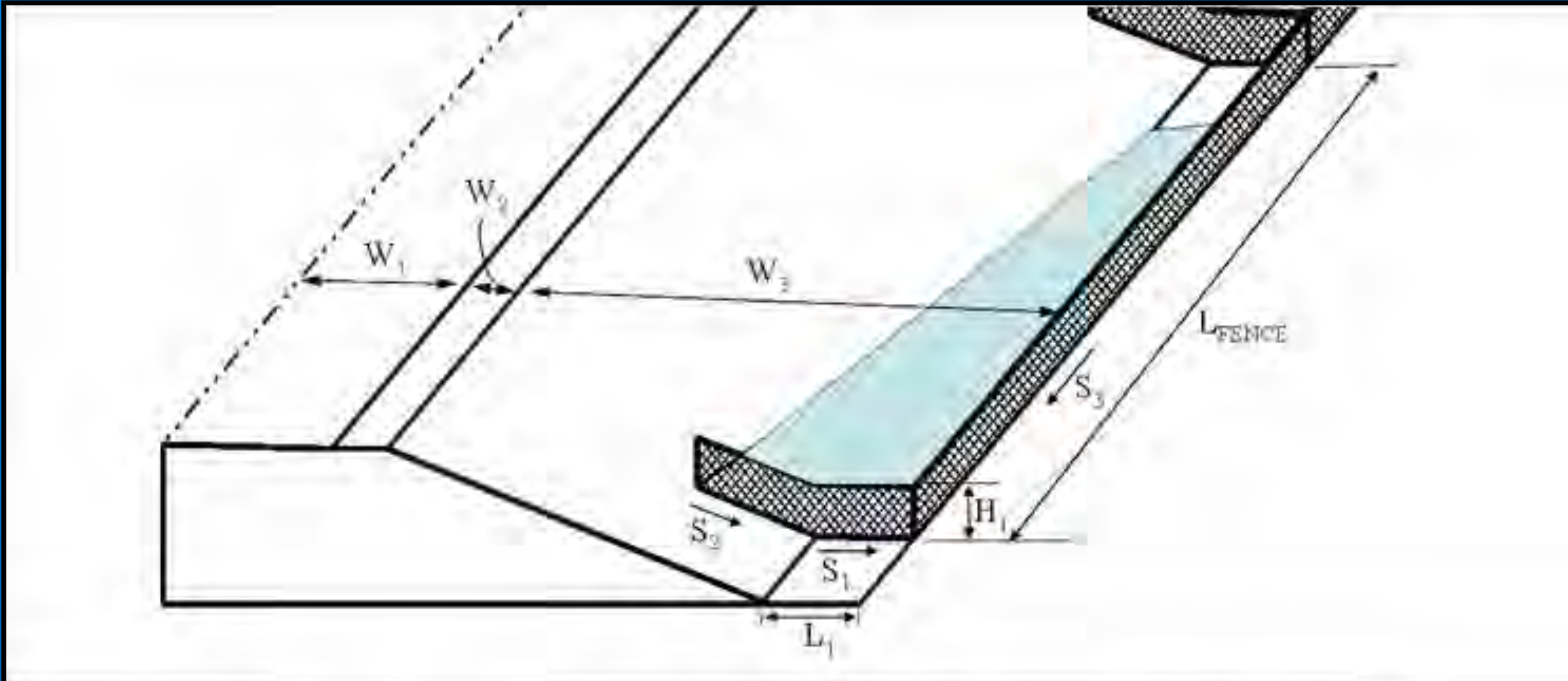
- Silt Fence Storage Capacity Component
  - Computes the storage capacity of various tieback configurations
  - Can be used to determine an adequate silt fence tieback configuration that can handle the total stormwater runoff volume computed by the stormwater runoff component

Application of Design Tool

Field Test Site: I-85 Exit 57

VARIABLE	VALUE
Roadway Length:	600 ft.
Roadway Width:	50 ft.
Roadway CN:	82
Fill Slope Gradient:	33.33%
Fill Slope CN:	82
Distance from Road to ROW:	50 ft.
Riprap Ditch Slope:	5%

Design Tool: Input



Stormwater Runoff Volume Computation	

Input:

Roadway CN:	82
Roadway Width from Centerline, W_1 (ft):	50
Roadway Length (ft):	300
Shoulder CN:	82
Shoulder Width, W_2 (ft):	0
Fill Slope CN:	82
Width from Shoulder to ROW, W_3 (ft):	50
2-yr, 24-hr Precipitation (in):	2

Silt Fence Storage Capacity Computation	

Input:

S_1 (ft/ft):	0
S_2 (ft/ft):	0.33
S_3 (ft/ft):	0.05
H_1 (ft):	3
L_1 (ft):	0

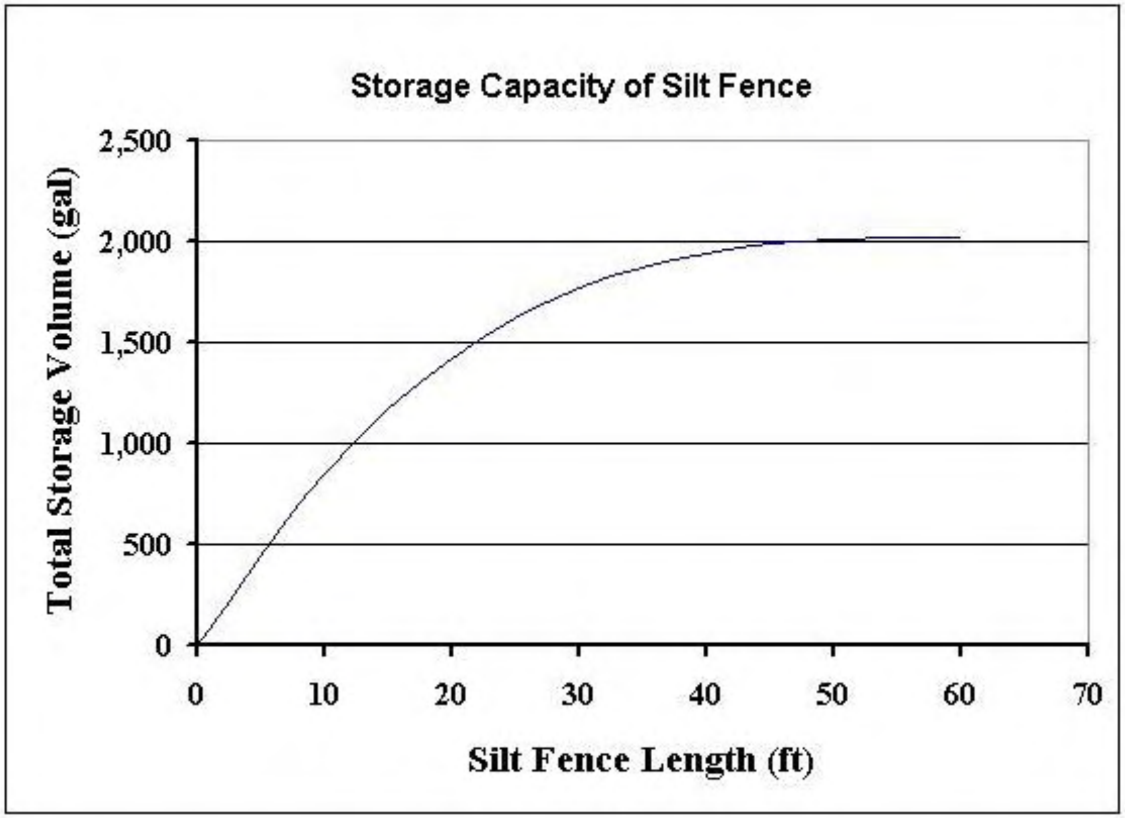
Design Tool: Output

Results:

Stormwater Runoff Volume (gal):	12,131

Results:

Silt Fence Length (ft)	Total Storage Volume (gal)
0	0
10	851
20	1,421
30	1,767
40	1,945
50	2,010
60	2,020



Linear Silt Fence System After Fourth Rainfall Event

Upslope End: Little Sedimentation

Downslope End: Heavy Sedimentation

Linear Silt Fence System After Fourth Rainfall Event

Erosion Along Toe of Fence

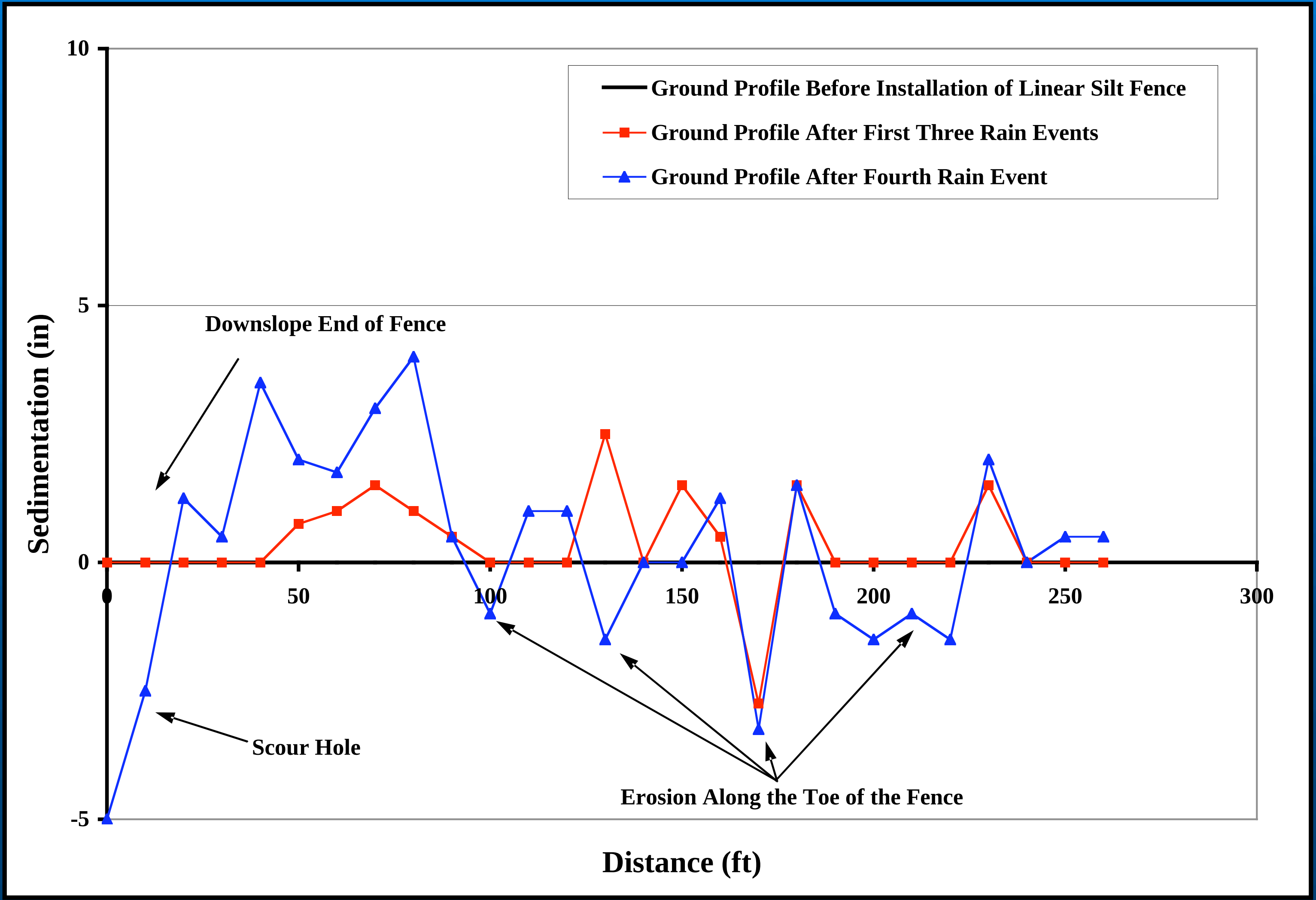
Erosion Along Toe of Fence

Linear Silt Fence System After Fourth Rainfall Event

Downslope End: **Before**

Downslope End: **After (Scour Hole)**

Sedimentation Profile of Linear Fence



Tieback System Performance After Fourth Rain Event

Tieback Section #1

Tieback Section #2

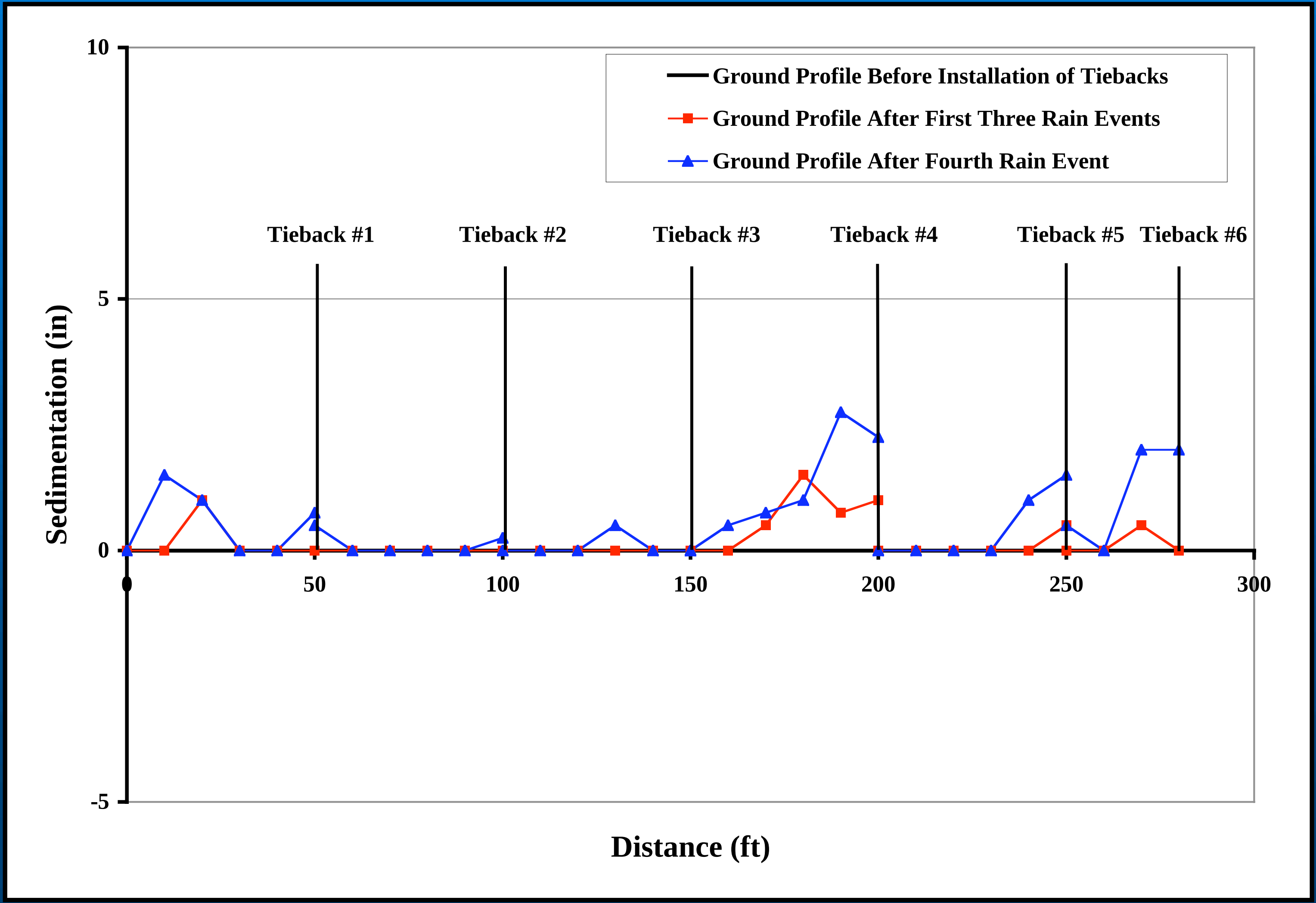
Tieback Section #3

Tieback Section #4

Tieback Section #5

Tieback Section #6

Sedimentation Profile of Tieback Sections



Silt Fence Conclusions

- The linear system experienced concentrated flow along the fence which led to heavy sedimentation and scouring at the downslope end of the system and erosion along the toe of the fence at many upslope locations. This system, if not maintained after future events, will eventually fail completely.
- The tieback system performed as expected by distributing the total sediment load between the six tieback sections and preventing erosion from occurring along the toe of the fence.

Introduction to PAM

- Anionic polyacrylamide (PAM)
  - Water-soluble
  - Negatively charged polymer chain
  - Serves as a binding agent for soil particles
    - Works very well with clays
  - Available in dry granular form or as a liquid emulsion
  - Commonly applied with other ground cover practices

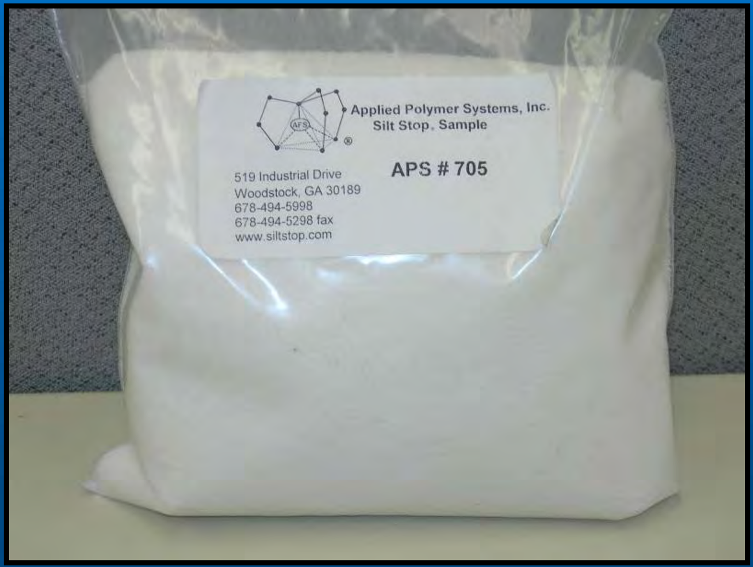
- Application methods
  - Dry granular
    - Using a spreader or by hand
    - Mixed with water and applied using a hydroseeder
  - Liquid emulsion
    - Applied using a hydroseeder

- Agricultural Applications
  - Slopes generally mild (i.e. < 10%)

- Construction Applications
  - Steeper slopes (> 10%)

Polymer Selection

- Soil Testing
  - Tests needs to be performed to determine the proper PAM product for that particular type of soil.
  - Different soils require different types of polymer, so there is not just one available PAM product.
- Polymer Selected for this Application
  - Soil-polymer testing performed by Applied Polymer Systems, Inc.
  - 705 Silt Stop powder at an application rate of between 35 – 45 lb/ac.



Experimental Design

- Intermediate-Scale Experiment
  - 3 in. of EPS material
  - SKAPS W200 Woven Geotextile Fabric.
  - 3 in. of a compacted silty sand material (3 - 1 in. lifts)
- Three Experimental Scenarios:
  1. Bare soil [Control Experiment]
  2. 20 lb/ac [Experiment 1]
  3. 40 lb/ac [Experiment 2]

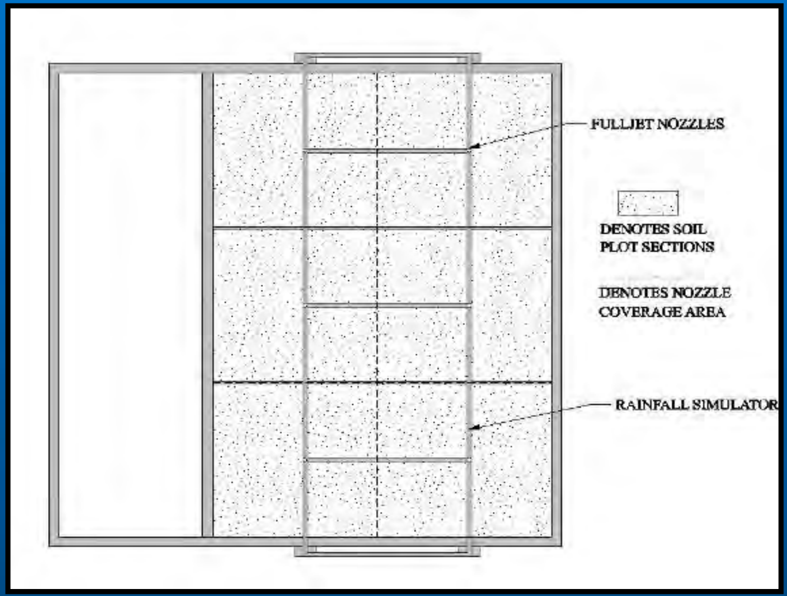

EPS Material


Geotextile Fabric

Silty Sand Material

Experimental Design

- A six nozzle rainfall simulator was designed to provide uniform coverage over the three soil plot sections.
- Rainfall Regimen Used for Testing
  - Three consecutive 6 in/hr, 15 minute storm events
  - One hour break between each storm
  - Approximately 5-yr, 15 minute storms for the Mobile, AL area.
    - Most conservative 5-yr, 15-minute rainfall event for the State of Alabama.



Simulator Configuration

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Experimental Design

- Data Collected
  - **Surface runoff**
    - Volume
    - Initial Turbidiy
  - **Infiltration**
  - **Total Suspended Solids (TSS)**
    - Surface runoff filtered through one micron Hayward single-length filter bags.

Collection Bucket

Filter Bag

First Rainfall Event (Run 1)

Control

PAM Applied at 20 lb/ac

PAM Applied at 40 lb/ac

Second Rainfall Event (Run 2)

Control

PAM Applied at 20 lb/ac

PAM Applied at 40 lb/ac

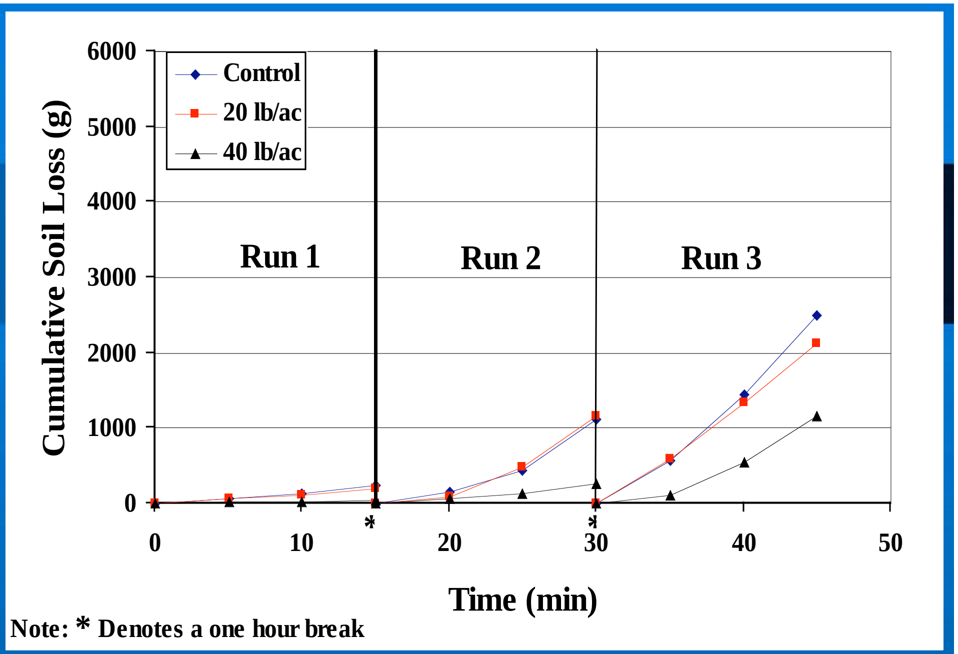
Third Rainfall Event (Run 3)

Control

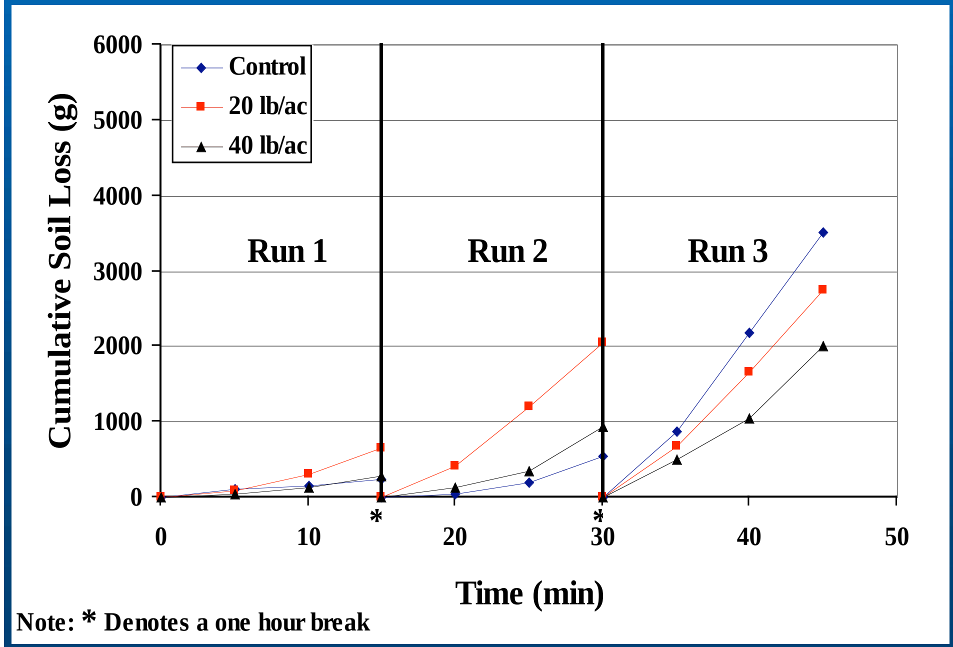
PAM Applied at 20 lb/ac

PAM Applied at 40 lb/ac

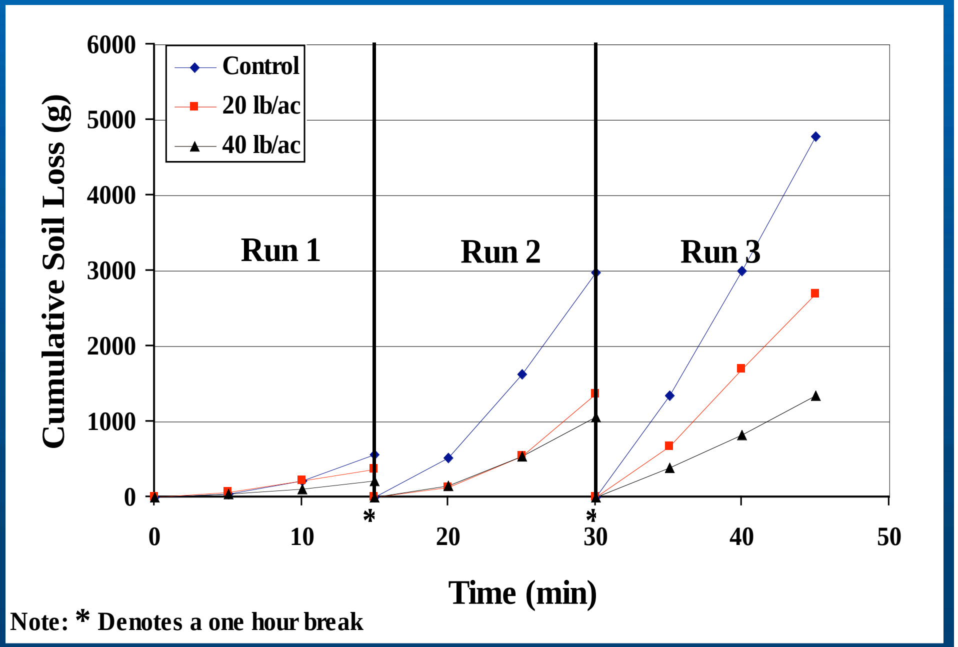
Cumulative Soil Loss vs. Time



Left Soil Plot



Center Soil Plot



Right Soil Plot

Cumulative Soil Loss Reduction

Soil Loss Reduction for PAM Applied at 20 lb/ac

	Left Soil Plot	Center Soil Plot	Right Soil Plot	Average of Plots
Run 1	18%	-180%	36%	-16%
Run 2	-5%	-278%	54%	1%
Run 3	15%	22%	44%	30%

Soil Loss Reduction for PAM Applied at 40 lb/ac

	Left Soil Plot	Center Soil Plot	Right Soil Plot	Average of Plots
Run 1	82%	-20%	62%	49%
Run 2	77%	-73%	64%	51%
Run 3	53%	43%	72%	58%

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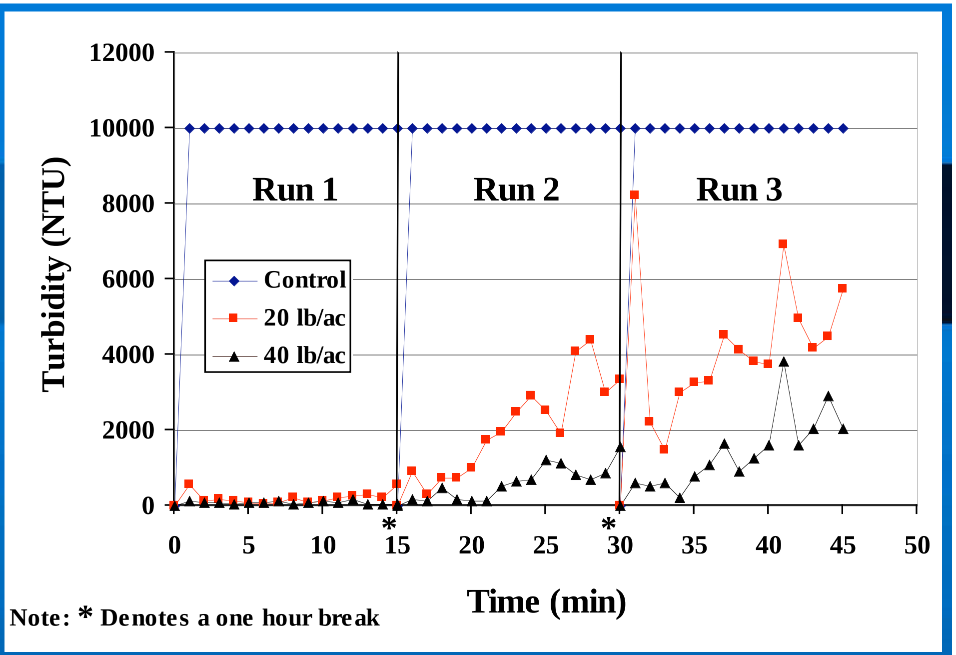
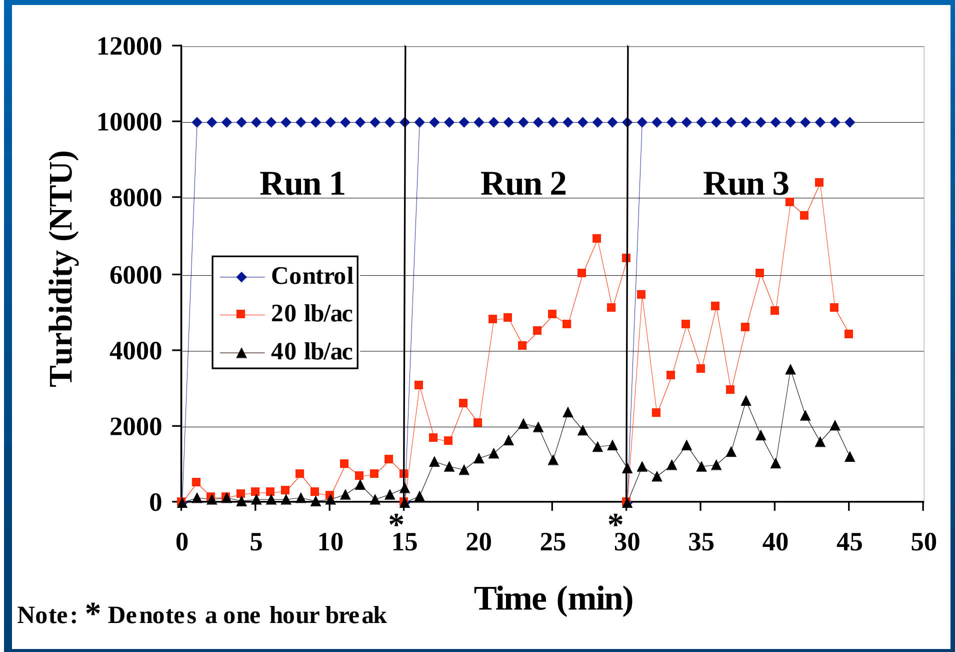
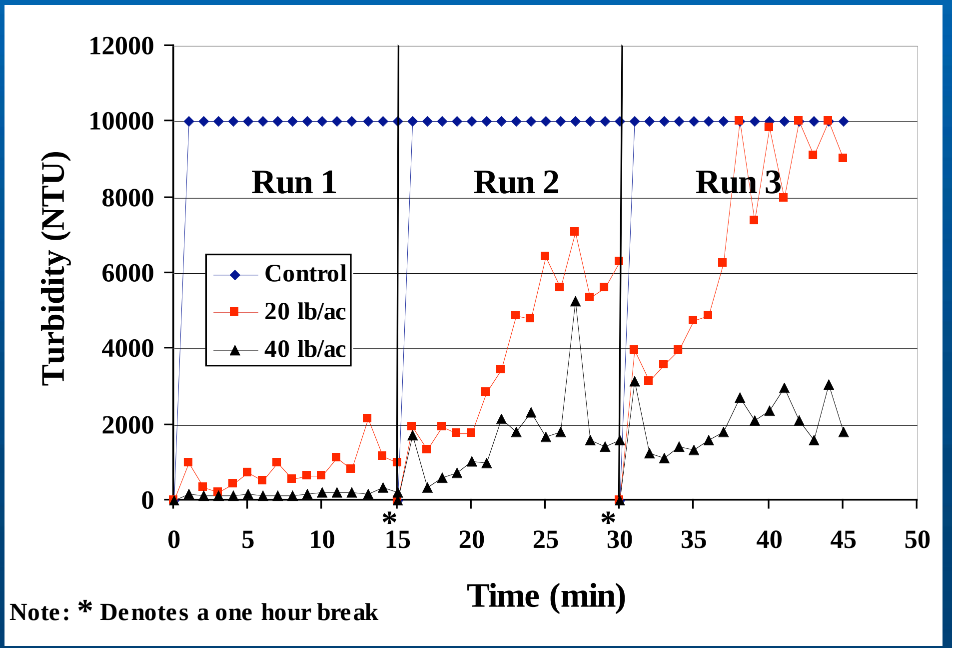
Initial Surface Runoff Turbidity vs. Time



Left Soil Plot



Center Soil Plot



Right Soil Plot

Turbidity Reduction

Initial Surface Runoff Turbidity Reduction

	PAM Applied at 20 lb/ac	PAM Applied at 40 lb/ac
Run 1	95%	99%
Run 2	65%	88%
Run 3	46%	83%

Initial Turbidity

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PAM Conclusions

- PAM applied in the dry granular form to a silty sand material could be a potential erosion control alternative if used at the proper application rate.
  - PAM applied at the recommended rate (40 lb/ac) reduced the average soil loss for all three rainfall events compared to the control.
  - PAM applied at half the recommended rate (20 lb/ac) reduced the average soil loss for only two of the three rainfall events.

- PAM applied for surface stabilization can provide sediment control benefits by reducing the initial surface runoff turbidity and also decreasing the settling time of suspended sediment in the runoff even when applied at half the recommended rate.

Questions???