

# Effective Stormwater and Sediment Control During Pipeline Construction Using a New Filter Fence Concept – Annual Report

**Period Covered by the Report:** 06-10-04 to 09-09-04

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**Title:** Effective Stormwater and Sediment Control During Pipeline Construction Using a New Filter Fence Concept

**Investigators:** Billy J. Barfield, Khaled A.M. Gasem, Marty Matlock

**Institution:** Oklahoma State University, University of Arkansas

**EPA Project Officer:** Bala Krishnan

**Project Period:** 9-10-03 to 9-9-04

**Project Amount:** \$159,734

**Research Category:** Pollution Prevention

## Description:

### Objective(s) of the Research Project Specified for Current Project Period:

1. Prepare and present two workshop at the IPEC meeting: a) an initial workshop to develop consensus among leading researchers, industry, and environmental agencies on design and performance criteria for new silt fence technology to be used in the petroleum industry (*completed and reported 1/10/04*)
2. Develop threshold design criteria for sediment control, effluent guidelines under Phase II SWP based on a regional impact analysis (*reported 7/12/04*)
3. Prove the FAEST silt fence design and implementation concept under laboratory and field conditions where current silt fence fails due to:
  - a. Flow concentrations that result from current installation technology
  - b. Failure to trap clays and fine silts addressed through: flow barriers

### Objective(s) Proposed for Year 2 Project Period to be Addressed in Current Project Period:

3. Prove the FAEST silt fence design and implementation concept under laboratory and field conditions where current silt fence fails due to:
  - b. Failure to trap clays and fine silts addressed through: use of polyacrylimide (PAM) applied upslope of the fence or fused onto the apron to enhance settling
5. Write proposed BMP guidelines and develop design aids for the technology
6. Develop design requirements for machine systems to install fences (*reported on 7/12/04*)

### Progress Summary/ Accomplishments (since 06/10/04):

#### Objectives 3a and 3b:

We have completed four “full” simulations wherein the field measurements were taken and laboratory samples were analyzed, plus two simulations that were for the purpose of assessing the experimental set-up and flow barrier configurations. The primary objective of these tests was to

develop information for modeling the hydraulics and trapping efficiency of the small impoundments and to compare the performance of the new technology with performance of existing technology. Existing technology was evaluated as part of a previous project that was completed earlier this year. Table 1 gives the test parameters.

| Date       | Slope | Soil       | Objective                        |
|------------|-------|------------|----------------------------------|
| 6/10/2004  | 10%   | Silty Clay | Test sample collection apparatus |
| 8/16/2004  | 10%   | Silty clay | Full data collection             |
| 8/24/2004  | 10%   | Loam       | Full data collection             |
| 9/10/2004  | 10%   | Clay loam  | Full data collection             |
| 10/1/2004  | 13%   | Clay loam  | Evaluate barriers                |
| 10/18/2004 | 13%   | Clay loam  | Full data collection             |
|            | 13%   | Sandy Loam | Full data collection             |
|            | 13%   | Silty clay | Full data collection             |
|            | 18.5% | Silty clay | Full data collection             |
|            | 18.5% | Sandy loam | Full data collection             |
|            | 18.5% | Clay loam  | Full data collection             |

The minimum turn-around time between simulations is one week, and we had planned to have nine full simulations completed during July through September, but unfortunately, the unusually rainy summer and fall resulted in losing about five weeks of work time. The remaining simulations should be completed before the end of November.

While limited, the series of tests to date has demonstrated that the new technology is effective in solving the problems with conventional fence stated in Objectives 3a and 3b. The placement of the apron upslope of the fence solved the problem of erosion along the toe of the fence, and there was no observed scour of material up from under the apron. In addition, the lateral flow barriers increased detention time and trapping efficiency. A comparison of trapping efficiency (TE) with equivalent tests of a conventional installation is in Table 2. The tests were comparable in that the rainfall rate, soils, fabric, and slope along the toe were the same.

| Soil       | Slope | TE-Conventional | TE-new |
|------------|-------|-----------------|--------|
| Sandy Loam | 10%   | -412%           | 81%    |
| Loam       | 10%   | -257%           | 58%    |

The trapping efficiency was computed as the ratio of the sediment retained in the fence to the sediment load from the source area. The negative trapping efficiency indicates that more soil was scoured from the toe trench than was transported from the source area. The toe trenches in these installations were completely scoured after 30 to 60 minutes of rainfall. The recommended 6-inch wide by 6-inch deep toe burial trench was used. With the new technology, there has been no failure by scour at the front of the apron (where it is anchored into the soil), and it does not appear that failure would occur, even if the rainfall was extended by several hours. The one problem observed was development of concentrated flow along the interface between the soil and the apron, particularly with the very erodible sandy loam soil. While there was no indication that the toe would eventually fail to be properly anchored in the soil or that undercutting would occur, the

problem caused by the concentrated flow was that the runoff would bypass the flow barriers and not enter the impoundments. This problem can be easily solved by providing a smoother transition between the soil and apron that will direct flow into the impoundments.

We therefore are very confident that the new technology has successfully addressed the problem of failure of the toe and resulting undercutting and that the addition of the flow barriers has greatly increased detention time and trapping, particularly of settleable solids.

Figures 1 through 4 are photos taken during the simulations.



Figure 1. Water and sediment impounded during the simulation



Figure 2. Impounded sediment after end of simulation (next day)



Figure 3. Simulation to test a variety of barriers



Figure 4. Sample collection troughs: left – through fence, center – through flow barriers, right – seepage under apron

Objective 3b: The investigation currently underway to identify various formulations of polyacrilimide (PAM) that have the best potential to enhance the flocculation of clay particles is progressing very well, and we anticipate completing the data set for one of our soils by the end of November. For this particular soil, we will identify the best PAM formulation, optimum concentration of PAM and optimum concentration of gypsum. The soil that we focused on first has a relatively high clay content, on the order of 30 to 40 percent. This analysis will also yield data for mathematical modeling of the change in size distribution resulting from the addition of PAM.

Objective 5: A framework for a mathematical model has already been developed as part of a previous project, and the rainfall – runoff – sediment yield relationships for the drainage area into

the fence are equally applicable here and can be adopted directly. The previous research also produced algorithms for defining the stage – discharge relationship through the silt fence. We will further refine these using the data obtained for the small impoundments included in the new technology. The component of the model defining the impoundment geometry and routing the flows has been developed, and the field data will be used to make any necessary modifications to account for the deposition in the impoundments and its impact on the head available to force flow through the fence.

#### **Publications/ Presentations:**

E.W. Stevens, Christianson, R.D, Barfield, B.J. 2004. Hydraulics of flow through and along silt fences. American Society of Agricultural Engineers Meeting Paper No. 04-2234. Joint ASAE and CSAE/SCGR Annual International Meeting, Ottawa, Ontario, Canada, August 2004.

Stevens, E.W., B.J. Barfield, K. Gasem, S. Yeri, J. Arjunan. 2004. The Failure Avoidance And Effective Silt Fence Technology (FAEST): Modeling And Laboratory Evaluation. Paper and presentation at IPEC Annual Meeting, Albuquerque, NM.

Arjunan, J., S. Yeri, E.W. Stevens, B.J. Barfield, K. Gasem. 2004. Application Of Polyacrilimide To Enhance Silt Fence Performance. Presentation at IPEC Annual Meeting, Albuquerque, NM.

**Future activities:** To complete the Year 1 activities, we plan to finish up the nine planned simulations – five to go – and analyze the data obtained from all the simulations with the following objectives in mind:

- Documenting that with the modifications to date, namely the apron and flow barriers, that we have addressed two of the major problems with conventional silt fence, i.e., failure of the toe and inadequate detention time.
- Collecting data to use for calibrating the mathematical model
- Finding an apron and barrier configuration that is the best possible considering effectiveness at trapping sediment, cost to fabricate, and time and cost to install.

The economic issues will be addressed with Objective 4 in Year 2 and the effectiveness is being addressed through the current round of testing.

**Supplemental Keywords:** Soil, sediments, pollution prevention, sustainable development, engineering, hydrology, south central, Oklahoma, EPA Region 6, petroleum industry, construction industry.