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# Evaluation of Selected Mulches and Specialty Erosion Control Products Under Simulated Rain

C. Earl Israelsen

Eugene K. Israelsen

William N. McNeill

CONWED CORPORATION

Final Report

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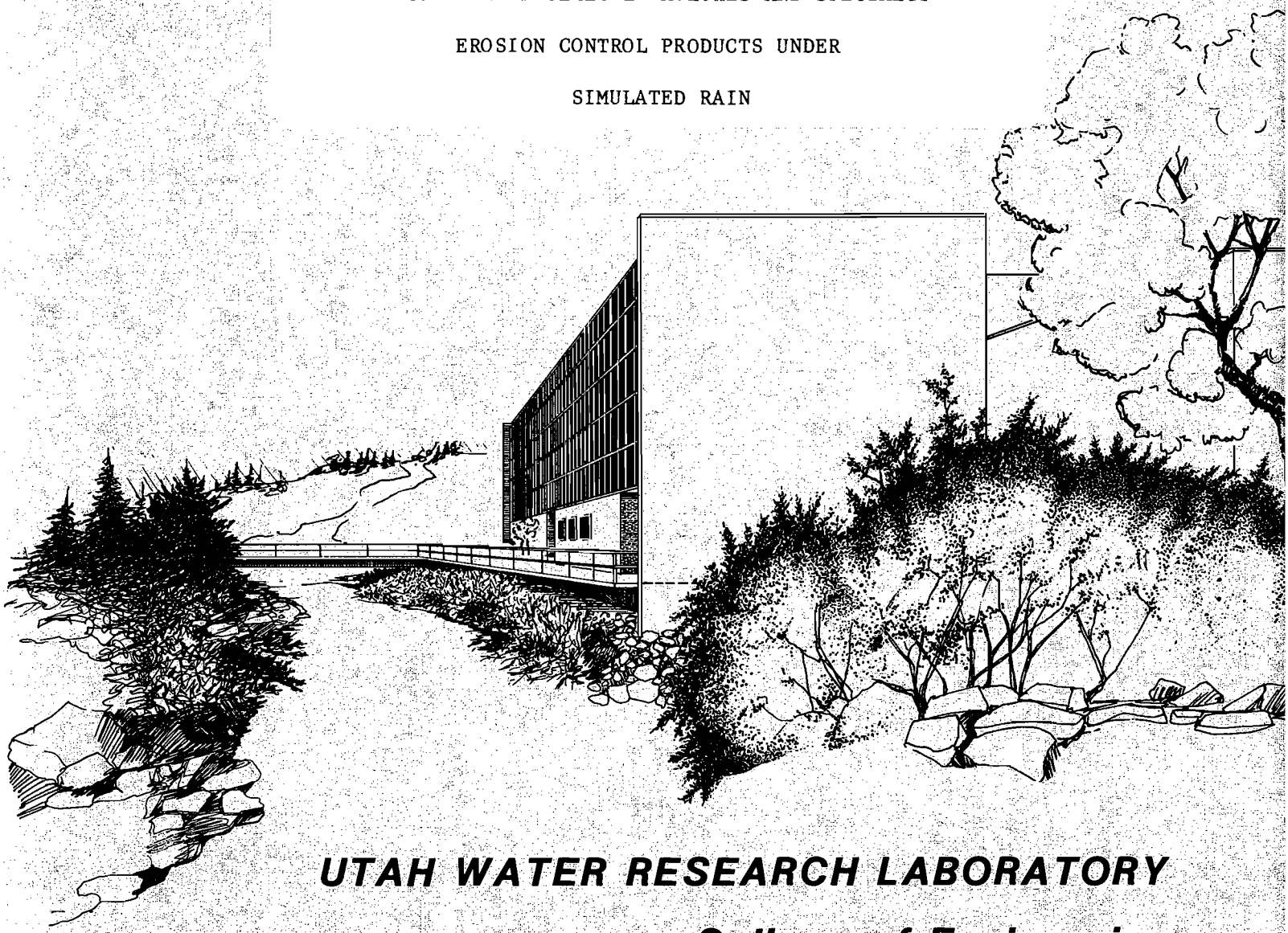

**UTAH WATER RESEARCH LABORATORY**

**College of Engineering**
**Utah State University**
**Logan, Utah**

CONWED CORPORATION

Final Report

# EVALUATION OF SELECTED MULCHES AND SPECIALTY EROSION CONTROL PRODUCTS UNDER SIMULATED RAIN

Utah Water Research Laboratory
Utah State University
Logan, Utah 84322

C. Earl Israelsen
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TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

Approximately 1-foot depth of soil is supported in the tilting flume by a metal grating covered with filter cloth through which water can drain. The flume is divided into three test plots, each measuring approximately 4 feet by 19.5 feet. These plots are separated from each other and from the side walls of the flume by 2-foot wide buffer strips. Runoff from each test plot is captured in a plastic tub, then is dried and weighed for determining the exact amount of mulch and soil leaving the plot.

The flume can be tilted hydraulically to any slope up to 43° from horizontal. Figure 1 shows the rainfall simulator in position over the tilting flume.

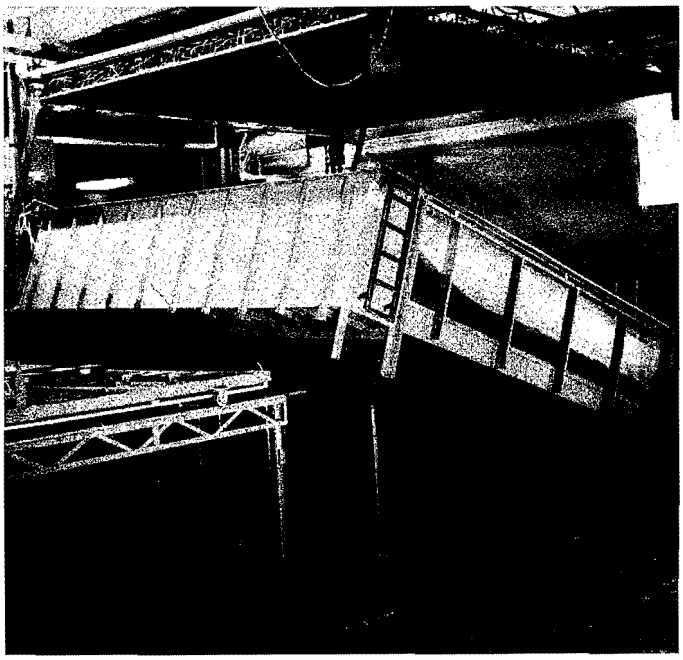


Figure 1. Rainfall simulator and tilting flume.

## Preparation for Tests

Two different series of tests were run, the first using CONWED Hydro Mulch mixed with various tackifiers, and the second using well-known specialty products. A slope of 2:1 (50 percent) was used on all the tests described herein. Rain was applied at the rate of 4 inches per hour on the Series I tests and 8 inches per hour on the Series II tests.

## Test Series I

Each of the three test plots was filled with soil of approximately the same composition as was used on previous tests, e.g., total sand = 28 percent; total silt = 49 percent; total clay = 23 percent; total organic matter = 2.7 percent. After every test run the top layer of soil and mulch was removed and discarded from each plot to the depth that erosion had occurred. New soil was added to replace that removed, and each plot was cultivated with a garden tiller to a depth of approximately 6 inches. It was then raked smooth and uniformly compacted with a lawn roller filled with water, and was ready for the next application of mulch. After the plots were prepared and mulch was applied, the test flume was tilted to the desired slope in preparation for rain application.

Materials tested under Series I were the following:

1. Regular Hydro Mulch at the rate of 1600 lbs/acre, mixed in a hydromulcher with Terra Tack I at the rate of 50 lbs/acre, and applied uniformly to the plots.

2. Regular Hydro Mulch at the rate of 1600 lbs/acre, mixed in a hydromulcher with M-Binder at the rate of 100 lbs/acre, and applied uniformly to the plots.

3. Regular Hydro Mulch at the rate of 1600 lbs/acre, mixed in a hydromulcher with Hydro Bond at the rate of 40 lbs/acre, and applied uniformly to the plots.

Test Series II

Soil used in the Series II tests was the same as that used in Series I, but it was prepared differently for the tests. It was placed in each plot in successive layers about 3 or 4 inches deep, and each layer was thoroughly compacted with a gasoline-engine-driven mechanical vibrator, to reduce water infiltration into the soil to a minimum. This was done to cause most of the rain to flow overland down the slope to encourage failure of the product rather than failure of the slope.

As in test Series I, the top layer of soil was removed after every test to the depth that erosion had occurred. New soil was added to replace that removed, and it was also compacted. Test materials were then prepared and applied.

Baled straw was run through a commercial straw blower, caught in a burlap bag, then applied uniformly to the test plots by hand at the rates specified. The following preparations were made for these tests.

1. Straw was applied at the rate of 2 tons/acre, then covered with CONWED netting. The netting was secured with 1" x 6" wire staples spaced at 36" intervals along each side and at 6" intervals along the top and botton edges. The staples along each side were placed 6" from the edge of the net.

2. Straw was applied at the rate of 1 1/2 tons/acre, then covered with jute blanket. The blanket was secured with 1" x 6" wire staples along the sides at 36" intervals, across the ends at 6" intervals, and down the middle at 36" intervals, staggered.

3. Jute matting was applied directly to the soil surface on each plot, then rolled with a lawn roller to assure that the mat was in close contact with the soil throughout. The matting was secured with 1" x 6" steel staples at 36" intervals along the sides, 6" intervals along the ends, and 36" down the middle, staggered.

4. American Excelsior blanket was applied directly to the soil surface on each plot, then secured with 2" x 6" steel staples along the sides at 36" intervals, across each end at 6" intervals, and down the middle at 36" intervals, staggered. The mat was rolled with a lawn roller after it was in place.

Determination of Erosion

As plot preparations were completed for each test, the flume was tilted to a slope of 2:1 and covered with a sheet of plastic. The rainfall simulator was turned on to full capacity to purge the air from the system. (During this purging the rain fell onto the plastic and ran into the drain without wetting the plots.) When the purging was complete the rainfall was adjusted to the desired rate per hour and allowed to stabilize. Plastic covering the flume was then quickly removed so the rain could fall directly onto the test plots, and the time clock was started. Total time was recorded from the instant that rain began falling onto the plots until failure of the mulch or specialty product, or of the plot itself occurred, or until the plastic tub catching the runoff was filled.

The water-sediment mixture in the tubs was allowed to stand until the suspended sediment had settled, then the water was decanted from the container. Heatlamps were positioned over the eroded sediment until it was completely dry, and then it was weighed.

## RESULTS AND DISCUSSION

### Results

Results of Series I tests are presented in Table 1 and Figure 2, and those of Series II in Table 2 and Figure 3. In accordance with procedures developed during previous tests, the apparent rate of erosion in each instance is regarded as the measure of effectiveness of the materials being tested for controlling erosion. The "apparent" rate of erosion is determined by dividing the total time to fill the runoff tub by the dry weight of the material eroded. Using this method and averaging the replications on each test, the results shown in Tables 3 and 4 are obtained.

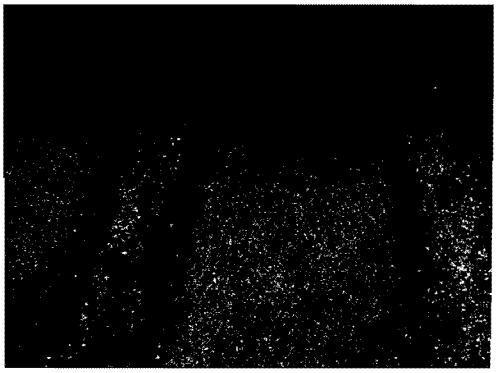
Series I tests. Nothing unusual was noted on any of these tests. No significant rills were formed, and the rate of erosion on each of the three replications appeared to be uniform throughout. There was not a mass failure of any of the mulches or slopes.

The following observations were made during the tests:

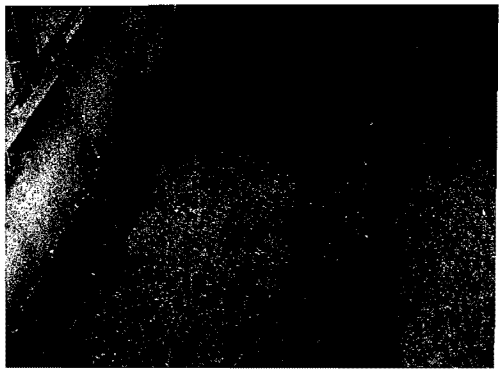
1. Terra Tack I had to be sifted uniformly into the water-mulch mixture during agitation to get it to dissolve. Whenever the material was put into the mix as a blob, it quickly formed a hard gelatinous mass that would not dissolve. This phenomenon was not noted with either the Hydro-Bond or the M-Binder.

Table 1. Results of Series I tests made under 4 inches/hr rainfall on a 2:1 slope.

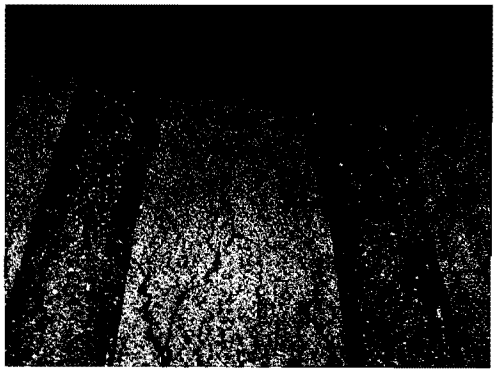
| Product | | Replications South | Center | North |
|---|---|---|---|---|
| 1. Hydro Mulch (1600 lbs/acre) Terra Tack I (50 lbs/acre) | Total Elapsed Time | 20'-35" | 19'-10" | 18'-0" |
| | Runoff Material | 10.0 lbs | 10.4 lbs | 10.0 lbs |
| | Apparent Erosion Rate | 0.486 lbs/min | 0.543 lbs/min | 0.555 lbs/min |
| | Average | | 0.528 lbs/min | |
| 2. Hydro Mulch (1600 lbs/acre) M-Binder (100 lbs/acre) | Total Elapsed Time | 17'-10" | 17'-10" | 17'-10" |
| | Runoff Material | 17.6 lbs | 13.9 lbs | 15.9 lbs |
| | Apparent Erosion Rate | 1.025 lbs/min | 0.810 lbs/min | 0.926 lbs/min |
| | Average | | 0.920 lbs/min | |
| 3. Hydro Mulch (1600 lbs/acre) Hydro Bond (40 lbs/acre) | Total Elapsed Time | 34'-40" | 32'-40" | 29'-10" |
| | Runoff Material | 6.7 lbs | 9.2 lbs | 8.6 lbs |
| | Apparent Erosion Rate | 0.193 lbs/min | 0.282 lbs/min | 0.295 lbs/min |
| | Average | | 0.257 lbs/min | |



1. After rainfall on Terra Tack I



2. After rainfall on M-Binder



3. After rainfall on Hydro Bond

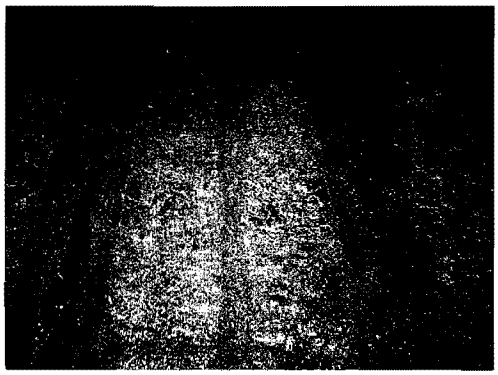
Figure 2. Test Series I.

Table 2. Results of Series II tests made under 8 inches/hr rainfall on a 2:1 slope.

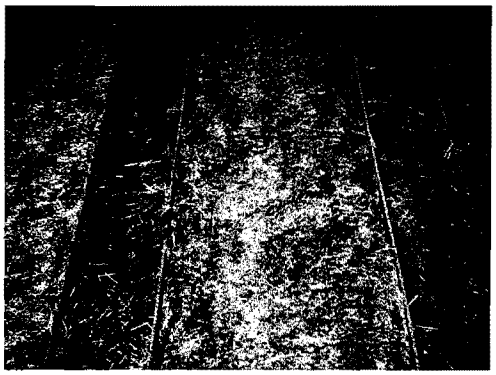
| Product | | Replications South | Center | North |
|---|---|---|---|---|
| 1. Compacted soil covered with 2 tons straw/acre, then covered with CONWED Netting | Total Elapsed Time | 11'-04" | 11'-30" | 10'-24" |
| | Runoff Material | 13.3 lbs | 10.2 lbs | 6.0 lbs |
| | Apparent Erosion Rate | 1.20 lbs/min | 0.89 lbs/min | 0.58 lbs/min |
| | Average | | 0.89 lbs/min | |
| 2. Compacted soil covered with 1 1/2 tons straw/ acre, then covered with jute blanket | Total Elapsed Time | 7'-04" | 6'-24" | 6'-48" |
| | Runoff Material | 3.4 lbs | 2.2 lbs | 1.1 lbs |
| | Apparent Erosion Rate | 0.48 lbs/min | 0.34 lbs/min | 0.16 lbs/min |
| | Average | | 0.33 lbs/min | |
| 3. Compacted soil covered with jute blanket | Total Elapsed Time | 6'-0" | 6'-30" | 7'-25" |
| | Runoff Material | 15.4 lbs | 14.4 lbs | 12.7 lbs |
| | Apparent Erosion Rate | 2.57 lbs/min | 2.22 lbs/min | 1.71 lbs/min |
| | Average | | 2.17 lbs/min | |
| 4. Compacted soil covered with Excelsior blanket | Total Elapsed Time | 10'-10" | 10'-25" | 10'-50" |
| | Runoff Material | 66.6 lbs | 27.3 lbs | 93.6 lbs |
| | Apparent Erosion Rate | 6.55 lbs/min | 2.62 lbs/min | 8.64 lbs/min |
| | Average | | 5.94 lbs/min | |

1. Conwed netting over straw. Center plot failed after 1-hour of rain at 8-inches per hour.

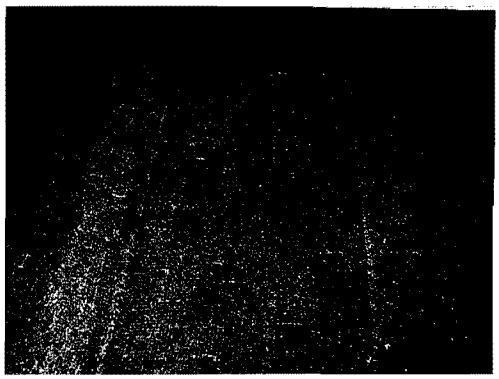
2. American Excelsior Blanket over compacted soil after 1-hour of rain at 8-inches per hour.



3. Jute blanket over straw after 1-hour of rain at 8-inches per hour.



4. Plots after jute and straw in No. 4 have been removed.



5. Jute blanket over compacted soil.

6. Plots after jute in No. 5 has been removed.

Figure 3. Test Series II. Pictures taken after 1-hour of rain at 8-inches per hour.

Table 3. Mulch effectiveness ranking as indicated by apparent erosion rate.

| Treatment | Apparent Erosion Rate | Ranking of Effectiveness |
|---|---|---|
| 1. Hydro Mulch with Terra Tack I | 0.53 lbs/min | 3rd |
| 2. Hydro Mulch with M-Binder | 0.92 lbs/min | 4th |
| 3. Hydro Mulch with Hydro Bond | 0.26 lbs/min | 2nd |
| 4. Hydro Mulch 2000 (tested previously) | 0.14 lbs/min | 1st |

Table 4. Product effectiveness ranking as indicated by apparent erosion rate.

| Treatment | Apparent Erosion Rate | Ranking of Effectiveness |
|---|---|---|
| 1. Straw with CONWED netting | 0.89 lbs/min | 2nd |
| 2. Straw with jute blanket | 0.33 lbs/min | 1st |
| 3. Jute blanket | 2.17 lbs/min | 3rd |
| 4. Excelsior blanket | 5.94 lbs/min | 4th |

2. The mulch slurry made with Hydro-Bond had a "slick" feel to it, and metal surfaces in the test flume that it contacted also became very slick. This condition did not exist with the other two tackifiers.

3. During the test of Hydro-Bond, a rill began to form at the lower end of the center plot very early in the run. Then it healed itself and no new ones developed during the remainder of the run.

Series II tests. Because of the compactness of the soil in this series of tests, very little water infiltrated into the soil and runoff began very soon after rain was first applied to the plots. The following observations were made as each test was run.

1. Two tons of straw per acre covered with CONWED netting.

a) Sediment continued to erode from the plots throughout the period.

b) Small holes eroded at random places on the plots, then straw would fall into them and stabilize them.

c) In places, sediment and straw piled up together, putting noticeable stress on the netting.

d) After 1 hour of running time the straw and sediment to a depth of 4 to 5 inches slid beneath the netting in the center plot. Staples in the lower half of the plot were pulled out by the slide, but staples on the top half of the slope kept the net from sliding.

e) Border effects were noticeable on all plots, i.e., small rills formed along these boundaries.

f) After 40 minutes of running time the erosion rate (measured on north plot only) was measured at 2.71 lbs/min.

g) After 1 hour of running at 8 inches per hour, rainfall on the north plot only was increased to 22 inches per hour for 15 minutes. This increased the erosion rate to 14.83 lbs/min. The rainfall rate was then increased again to 27 inches per hour for 10 minutes, and the plot still remained stable.

h) The north and south plots had a total running time of 1 hour and 25 minutes. Net and staples were still intact, and there was some displacement of the straw.

2. One-and-a-half tons of straw per acre covered with jute blanket.

a) The jute blanket, when wet, was noticeably heavier than the CONWED netting and pressed firmly against the layer of straw.

b) Small holes formed in the soil where the straw was sparse, but these quickly sealed themselves.

c) After about 8 to 10 minutes of running time, the runoff from the plots was quite clear, indicating minimum erosion occurring.

d) Each staple formed an effective dam to material moving from above it. (This effect was noted on the tests of all four products.)

e) Rainfall was maintained on all three plots at the rate of 8 inches per hour for a total running time of 1 hour.

f) After 40 minutes of running time the erosion rate (measured on north plot only) was 0.28 lbs per minute. At the end of an hour it was 0.43 lbs/minute.

3. Jute blanket on bare soil.

a) As soon as the mat became wet, each strand of jute along the contour of the slope became a miniature dam to sediment moving downslope. However, because these dams were low, water and sediment gradually flowed over their tops and moved slowly downhill.

b) Runoff from all three plots began about the same time and appeared to be uniform.

c) After 40 minutes of running time the erosion rate (measured on north plot only) was 2.62 lbs/minute, and after one hour was 2.40 lbs/minute.

d) Erosion was very uniform over the total slope because of the heavy mat being in contact over the entire surface, and erosion pockets could not form.

4. Excelsior blanket on bare soil.

a) When wood fibers and ground surface became saturated, fibers and soil slid downslope beneath the netting, forming dams at each staple. As water continued to run, it flooded over dams in some places and went around them in others, eventually developing rills, then gullies.

b) All three slopes exhibited partial failure within 10 minutes of running time, allowing fibers and soil to slide downslope. The center slope failed again about 7 minutes later and the material slid further downslope, lodging against staples at the lower end of the blanket.

c) When the center plot failed, a dam was formed at the lower end of the plot which forced part of the runoff to the sides onto the walkways, and missing the catchment. Thus, the sediment amount recorded in Table 2 for the center plot is in error. The same is true to a much lesser extent on the north and south plots as well.

d) Slopes reached a near-equilibrium condition where no noticeable further change was occurring with time.

e) After 40 minutes of running time the erosion rate (measured on the north plot only) was 2.61 lbs/minute.

f) After 1 hour of running time at 8 inches/hour, the rate on the north plot only was increased to 22 inches per hour, which increased the erosion rate to 10.7 lbs/minute. This higher rate noticeably increased the flow down the slope and deepened the gullies, but no further movement or failure of the Excelsior mat occurred during 15 minutes of running. The center and south plots continued to run for this period at 8 inches per hour and appeared to be stable except for gradual deepening of the gullies.

g) Total running time for all three plots was 1 hour and 15 minutes.

## Discussion

Series I tests. Based on the soil and test conditions described in this report, the amount of each tackifier mixed with the mulch, and the application rates per acre of the products tested, the results indicate that Hydro Bond mixed with regular Hydro Mulch is the most effective for controlling erosion. It is less effective in this regard, however, than Hydro Mulch 2000 which was evaluated previously under similar testing conditions. Increasing the application rates of the tackifiers tested may have a beneficial effect on the performance of the mulches in controlling erosion.

Series II tests. Tests in this series are basically of three different types of material; straw covered with netting, excelsior covered with netting, and netting against the bare soil. One would expect all

net-covered straw runs to behave about the same if they are on the same soil and slope, and have similar rainfall conditions. That appeared to be so on the tests run herein, one straw-covered plot under jute netting and the other under plastic netting. Even though the wet jute was heavier than the plastic netting, the most noticeable difference between the two sets of tests was the absence of staples down the middle of the plots covered with plastic net. This may account for the slight difference noted in rates of erosion between the two sets of plots. The jute had staples at 36-inch intervals along each side, and a row down the middle, while the plastic netting was stapled only along the sides. Each staple provides a dam to soil that begins to move down-slope, so increasing the number of staples per square yard of material adds to its effectiveness in decreasing erosion.

Field installations of net-covered straw, very similar in appearance to those constructed for these tests, have been observed by the investigators in places such as swales and down-drains where considerable overland flow was present. There, as here, it was noted that straw and soil piled up against the staples, at times causing them to fail, but most of the protective cover remained in place. In the field, net-covered straw on flat side slopes generally behaves differently than on the laboratory compacted slopes, because there most of the water infiltrates, leaving little to flow overland. In those instances, the amount of erosion is minimal, unless the storm lasts long enough to saturate the slope, causing it to fail.

The behavior of the excelsior-covered plots was also similar to like installations observed in the field. The wood particles do not cover the ground surface as completely as does the straw, and it also

does not seem to be quite as stable against the water flowing over it. Small rivulets form beneath the netting carrying soil and wood-fiber in tortuous paths downslope. When overland flow is significant, the final result is tufts of soil and wood-fiber anchored at each staple, with rills and sometimes small gullies formed down the slope between them.

Jute netting placed loosely over bare soil forms an effective barrier to small amounts of water moving as sheet flow down the slope. As the flow increases, water and soil move up through the net and flow over the top of it, down the slope. Field observations by the investigators indicate that when the soil is loosely compacted, and/or when the amount of water flowing is excessive, holes will erode beneath the jute netting, sometimes to depths of several feet. Numerous jute-covered sites in the field have been observed that were similar in appearance to the end results of the jute-covered plots in the laboratory tests.

## SUMMARY

Based on the test conditions described in this report, the amount of tackifier mixed with the mulch, and the application rates per acre of the products tested, the results of test Series No. I indicate that Hydro Bond mixed with regular Hydro Mulch is the most effective for controlling erosion. It is less effective in this regard, however, than Hydro Mulch 2000 which was evaluated previously under similar testing conditions.

Likewise, the results of test Series No. II indicate that jute blanket over straw is the most effective of the four treatment combinations tested.

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