RESEARCH REPORT DOCUMENTATION PAGE

1. Report No.	2. Report Date	3. Contract No.	4. Project No.
ND 96-02	March 1999	N/A	DPC-1-806(018)062

5. Title and Subtitle

Evaluation Of Soil Guards® Bonded Fiber Matrix For Erosion Control

6. Report Type

Work Plan ☐
Construction ☐
Evaluation ☐
Final ☒

7. Project No.

8. Project No.

9. Project No.

10. Project No.

11. Author(s)/Principle Investigator(s)

Jeff M. Richter

12. Performing Organization Name and Address

NDDOT M+R ☒
NDDOT OTHER* ☐
NDSU ☐
UND ☐
UGPTI ☐
OTHER* ☐
*see supplementary notes

North Dakota DOT
Materials and Research Division
300 Airport Road
Bismarck ND 58504-6005

13. Sponsoring Agency Name and Address

North Dakota DOT
Materials and Research Division
300 Airport Road
Bismarck ND 58504-6005

14. Supplementary Notes

15. Abstract

Purpose and Need

Erosion control is a never ending problem facing new or regraded projects. Steep slopes on some roadways need extra attention and erosion is difficult to prevent. New or improved products need to be investigated that might address this problem.

Objective

The objective of this study was to evaluate the effectiveness of a bonded fiber matrix, brand name Soil Guard® from Weyerhaeuser Engineered Fiber Products, in preventing soil erosion from highly erodible slopes.

Scope

The scope of this study involved comparing the effectiveness of Soil Guard® and double netted straw mat on 2:1 slopes or greater to compare Soil Guard® to our normal erosion control. Project DPC-1-806(018)062 is located on North Dakota 1806 bypass of Fort Lincoln State Park approximately 6 miles south-southwest of Mandan, North Dakota. The project will be observed and evaluated for two years and will include the following items. (1) Observe the installation process (2) Observe the effectiveness of preventing or reducing soil erosion over time. (3) Observe, record, and photograph the rate of return of vegetation to the slopes. (4) Conduct a cost comparison between the Soil Guard and other erosion control methods.

Summary

The project was completed according to the plans with the exception that the seed was not broadcast but incorporated into the Soil guard®. Sections G, H, and I are double seeded, as it was not know at the time of installation of the soil guard that these sections had previously been seeded by a drill. The Section "I" Soil guard® was placed approximately six feet short of the top of the slope and the coverage of the section seems "light" as shown in Photo 2. Section I is on the right side of the photo.

The atmospheric conditions at the time of application were not ideal, given the wind speeds. However, the application of the Soil guard® appeared to adequately cover the soil, except in the aforementioned area "I".

As a part of this test section, an evaluation of the soil conditions and nutrients was performed. The test results indicate that NDDOT should consider revising the fertilizer specifications to area specific requirements instead of a standard application rate of fertilizer. Experimental sections were installed by change order at a cost of $7,352.61. The cost of the Soil Guard® Bonded Fiber Matrix, for this project was $1.85 per S.Y. whereas the double netted straw blanket was $3.00 per S. Y. The NDDOT specifications allow the use of this type of application on slopes greater than 3:1 or on areas too small to seed with a drill.

Recommendation

Given the performance of the materials, despite the climatic conditions, and Soil Guard® costing $1.85/SY compared to the double-netted straw mat cost of $3.00/SY, it is recommended that Soil Guard® be used on steep slopes to control erosion, and that each project site have the soils tested for fertilizer needs specific to its location.

16. Key Words	17. Distribution Statement	18. No. of Pages
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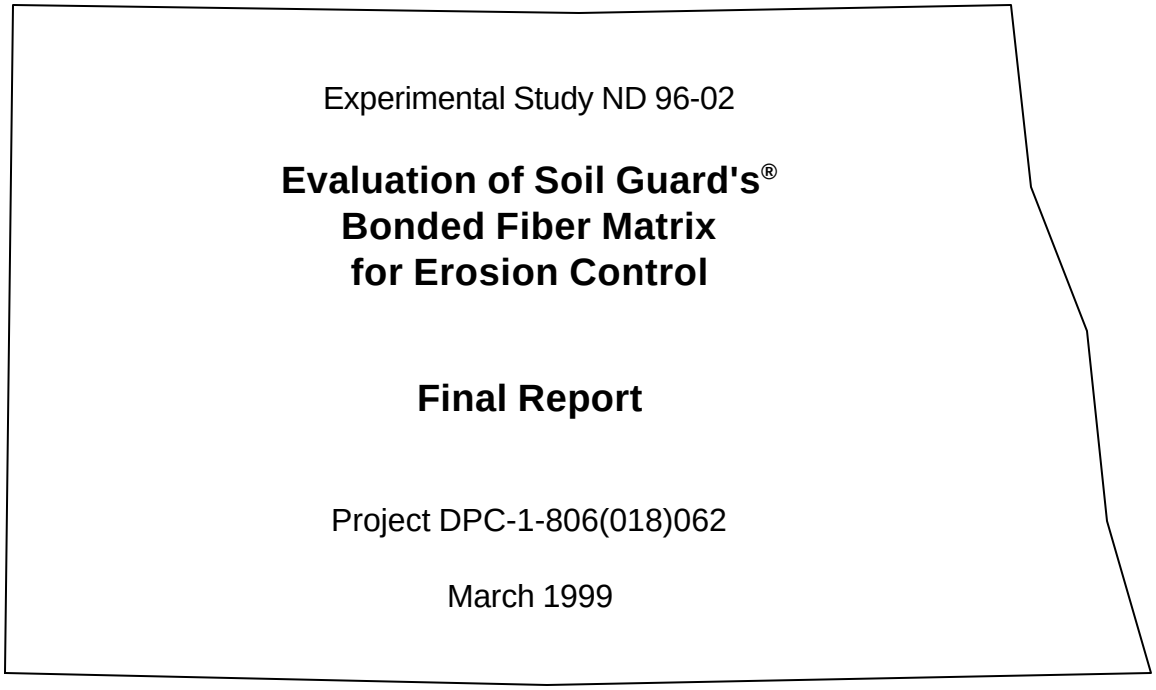
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION



Experimental Study ND 96-02

Evaluation of Soil Guard's® Bonded Fiber Matrix for Erosion Control

Final Report

Project DPC-1-806(018)062

March 1999

Prepared by

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
BISMARCK, NORTH DAKOTA
Website: http://www.discovernd.com/dot/

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Marshall W. Moore

MATERIALS AND RESEARCH DIVISION
Ron Horner

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO.

	STATE	YEAR		NUMBER	SURF
1	ND	96	-	02	

CONSTRUCTION PROJ NO: DPC-1-806(018)062 (8)

LOCATION: Morton County (28)

EVALUATION FUNDING

1 X HP&R
2 CONSTRUCTION
3 DEMONSTRATION
4 IMPLEMENTATION
(48)

NEEP NO. (49)

PROPRIETARY FEATURE? (51)
X Yes
No

SHORT TITLE

TITLE (52): Evaluation of Soil Guard's Bonded Fiber Matrix For Erosion Control

THIS FORM

DATE (140): 0 1 - 9 9 (MO. - YR.)

REPORTING: 1 INITIAL 2 ANNUAL 3 X FINAL

KEY WORDS

KEY WORD 1 (145): Slopes

KEY WORD 2 (167): Erosion Control

KEY WORD 3 (189): Sprays

KEY WORD 4 (211):

UNIQUE WORD (233):

PROPRIETARY FEATURE NAME (255): Soil Guard

CHRONOLOGY

Date Work Plan Approved	Date Feature Constructed:	Evaluation Scheduled Until:	Evaluation Extended Until:	Date Evaluation Terminated:
0 6 - 96	1 0 - 96	10 - 9 8		0 1 - 9 9
(277)	(281)	(285)	(289)	(293)

QUANTITY AND COST

QUANTITY OF UNITS: 2047 (297)

UNITS (305):

1 LIN. FT
2 X SY
3 SY-IN
4 CY
5 TON
6 LBS
7 EACH
8 LUMP SUM

UNIT COST (*Dollars, Cents*): 1.8 5 (306)

AVAILABLE EVALUATION REPORTS

(315)

X CONSTRUCTION

X PERFORMANCE

X FINAL

EVALUATION

CONSTRUCTION PROBLEMS (318)

1 NONE
2 X SLIGHT
3 MODERATE
4 SIGNIFICANT
5 SEVERE

PERFORMANCE (319)

1 EXCELLENT
2 GOOD
3 SATISFACTORY
4 MARGINAL
5 UNSATISFACTORY

APPLICATION

(320)

1 ADOPTED AS PRIMARY STD.
2 PERMITTED ALTERNATIVE
3 ADOPTED CONDITIONALLY
4 PENDING
5 REJECTED
6 NOT CONSTRUCTED

(Explain in remarks if 3, 4, 5, or 6 is checked)

REMARKS

321 Results were good for soil guard - comparable to double-netted straw mat in performance but more cost effective and easier to construct.

(700)

Form FHWA 1461

Experimental Study ND 96-02

EVALUATION OF SOIL GUARD'S® BONDED FIBER MATRIX FOR EROSION CONTROL

FINAL REPORT

DPC-1-806(018)062

MARCH 1999

Research Team Members
DESIGN DIVISION
BISMARCK DISTRICT
FEDERAL HIGHWAY ADMINISTRATION

Report Written
By
Jeff M. Richter

Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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EVALUATION OF SOIL GUARD'S® BONDED FIBER MATRIX FOR EROSION CONTROL

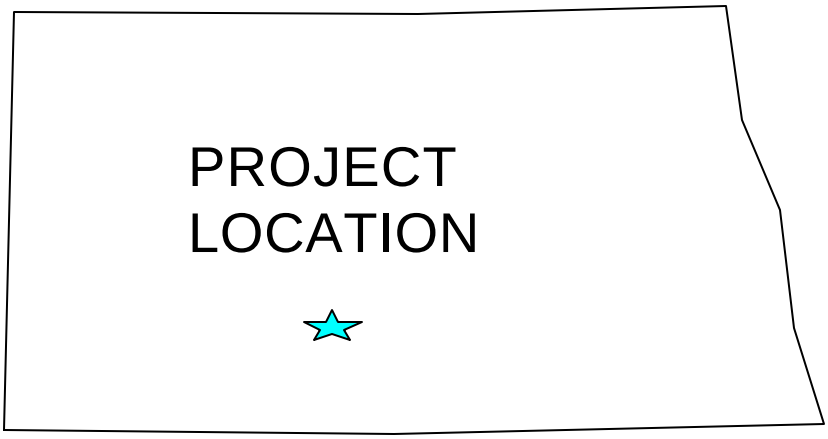
DPC-1-806(018)062
FINAL REPORT
ND 96-02

Objective

The objective of this study was to evaluate the effectiveness of a bonded fiber matrix, brand name Soil Guard® from Weyerhaeuser Engineered Fiber Products, in preventing soil erosion from highly erodible slopes.

Scope

The scope of this study involved comparing the effectiveness of Soil Guard® and double netted straw mat on 2:1 slopes or greater to compare Soil Guard® to our normal erosion control.



Location The project is located on the North Dakota 1806 bypass of Fort Lincoln State Park, approximately 6 miles south-south west of Mandan, North Dakota.

Design

Soil Guard® is a bonded fiber matrix, a new class of erosion control product pioneered by Weyerhaeuser. The term is being accepted within the erosion control industry to categorize hydraulically applied products which are designed, tested and proven to match or exceed the performance of erosion control blankets.[1]

A bonded fiber matrix is a continuous layer of elongated fiber strands held together by a water-resistant bonding agent. It eliminates direct rain drop impact on soil (it has no holes greater than one millimeter in size), it allows no gaps between the product and the soil and it has a high water-holding capacity. A bonded fiber matrix will not form a water-insensitive crust that can inhibit plant growth, and it will biodegrade completely into materials known to be beneficial to plant growth.[2]

Construction

EXPERIMENTAL SECTIONS

STATION 309+00 RIGHT TO STATION 311+00 RIGHT

STATION 320+50 RIGHT TO STATION 323+00 RIGHT

Station 309+00 Right to station 311+00 Right and station 320+50 Right to station 323+00 Right are located on the inslope of fill areas and are on the outside of a curve section of roadway. These areas have slopes of approximately 2:1, the slopes extend from the edge of the graded shoulder downward to the toe of the slope.

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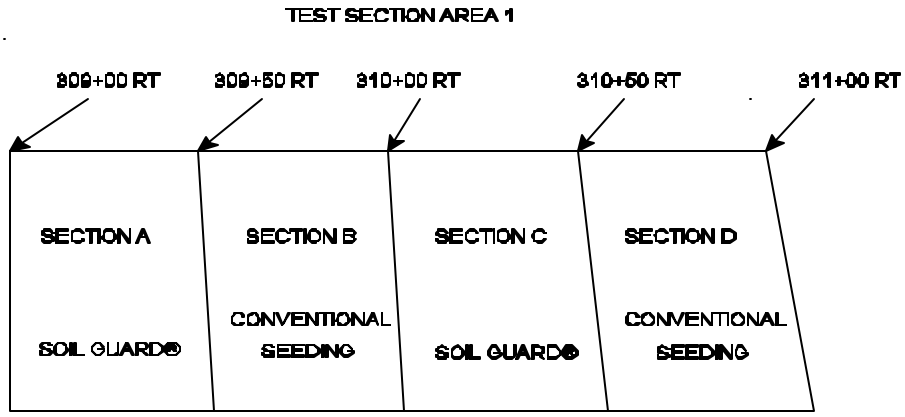
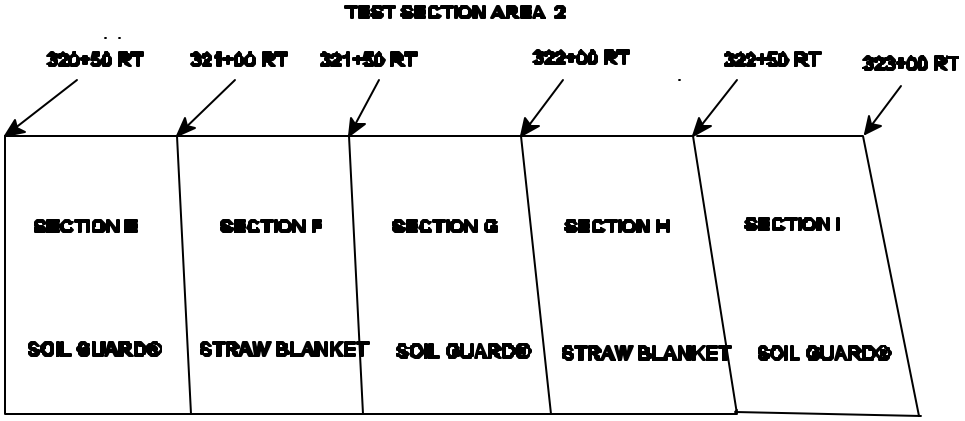
[1]Technical Bulletin, Weyerhaeuser Soil Guard® Bonded Fiber Matrix Erosion Control System. 7/94

[2] Ibid.

DPC-1-806(018)062





The prime contractor for this project is Orrin A. Holen Construction Inc. from McClusky, North Dakota. Magic Mile Welding is the sub-contractor for the erosion control items. They installed the double netted straw mat and S&B Landscaping installed the Soil Guard® fiber.

The sections were to be seeded by the broadcasting method, however on the day that the application was to take place, the wind velocities were in the steady 15 mph range with gusts to 20 - 30 mph.

Photo 1 - Application Unit

The contractor requested and was allowed to mix the seed with the Soil Guard® and it was applied in that manner. A Weyerhaeuser representative at the site made the recommendation that mixing the seed with the Soil Guard® was the preferred method of seed and fertilizer application. During the application of the Soil Guard® it was noticed that section H, I and part of G appeared to have been seeded with a drill. (See Photo 2) There was no one at the site to verify this. It was later confirmed that sections H, I and part of G were seeded by drill. Thus those sections were double seeded.

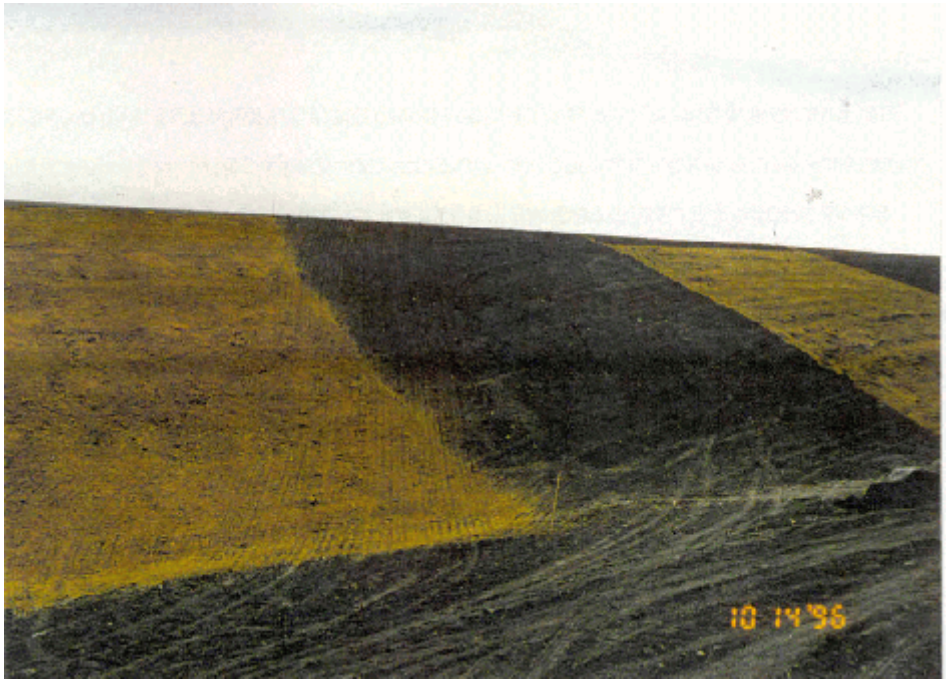


Photo 2 - Sections that appeared to have been seeded by a drill.

The Soil Guard® Bonded Fiber Matrix is applied hydraulically, with a general ground coverage rate of 3,000 lbs/acre.


Photo 3 - Hydraulically applying the Soil Guard® Bonded Fiber Matrix.

There is also a topographic index guide supplied with Soil Guard® that gives a rate increase of lbs/acre that must be taken into account when determining the actual application rate. The chart includes an adjustment for the slope of the area and an adjustment for the type/condition of the soil. For example a 2:1 slope that has been disced indicates that there is a 25% increase in effective surface area that needs to be covered and will require 750 additional pounds per acre to be figured in estimating quantities.

Photo - 4 Indicating conditions.

Weyerhaeuser supplied an application reference chart to the application crew, which indicated that given the tank capacity of the machine used to apply the fiber, six (6) 50-lb bags of Soil Guard® required 750 gallons of water to cover an area of 4,350 square feet. See Appendix 1 for the application chart.

Photo - 5 Demonstration of application.

Photo -6 Finished product.

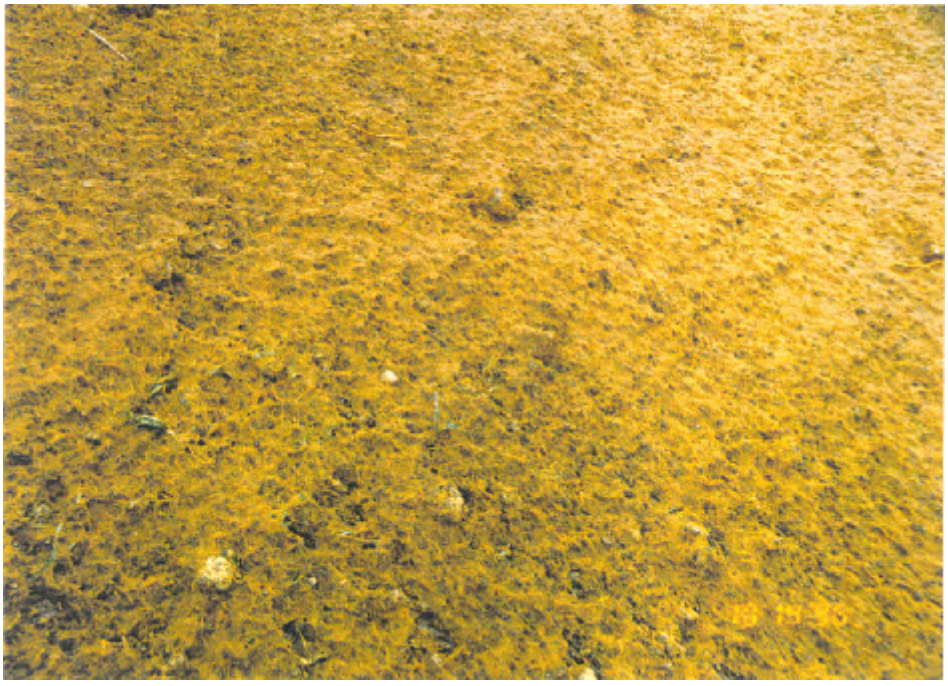


Photo - 7 Close up of finished product.

The straw mat was a double netted and was installed by excavating a small "vee" ditch at the top of the slope, laying the edge of the rolled matting in the ditch, backfilling the ditch to hold the mat in place, and then rolling the mat down the slope. Photos 8 - 12 show the installation and the stapling of the mat to the slope with a device that places wire staples into the ground. The stapling device shown in photo 11 was used to place the (6") six inch staples (photo 12) at a spacing of approximately 6" apart.

Photo - 8 Straw mat installation.

Photo 9 - View of nearly finished slope.

Photo - 10 Stapling the straw mat.

Photo - 11 Stapling Device.

Photo - 12 Wire Staples.

Evaluation

The topsoil in the test sections was sampled and tested for various properties as shown in the tables below:

PH<7 = ACID PH >7 = ALKALI

TEST SITE	PH	TEST SITE	PH
A - TOP	7.69	A - BOTTOM	7.74
B - TOP	7.72	B - BOTTOM	7.82
C - TOP	7.71	C - BOTTOM	7.73
D - TOP	7.72	D - BOTTOM	7.72
E - TOP	7.78	E - BOTTOM	7.43
F - TOP	7.81	F - BOTTOM	7.48
G - TOP	7.62	G - BOTTOM	7.66
H - TOP	7.63	H - BOTTOM	7.71
I - TOP	7.55	I - BOTTOM	7.71

Additional tests were submitted to North Dakota State University for determination of various nutrients found in the soils.

TEST SECTION	NITROGEN	PHOSPHORUS	SOLUBLE SALTS
B - TOP	39	4	0.42
B - BOTTOM	30	4	0.38
C - TOP	45	8	0.45
C - BOTTOM	37	5	0.44
G - TOP	45	5	0.50
G - BOTTOM	38	3	0.41
H - TOP	63	5	0.46
H - BOTTOM	53	5	0.45

The plans called for the application of 20 lbs/acre of nitrogen and 20 lbs/acre of phosphorous to be applied to the area, which is the standard application rate for Type II seeding as specified in the specifications. The fertilizer was spread by a broadcast method several days in advance of the seeding, the results of the tests indicate that there was an uneven application of fertilizer as can be seen by the differences in the soil test results. The average of the nitrogen is 44 lbs/acre which is slightly below the 50 lbs/acre recommended by the North Dakota State Extension Service for Native Grass. The average of the phosphorous is 4.9 parts per million (ppm) which seems to indicate that the soil is still low in phosphorous after the application of the fertilizer. NDSU Extension Service recommends that the ppm should be in the 14 to 17 ppm range. To achieve that level of phosphorous it is recommended that 40 lbs/acre of fertilizer be applied. (See appendix A for NDSU Extension Service recommendations.)

This project was evaluated during the months of April, May, and July of 1997. The Bismarck-Mandan area rainfall for the period of April to September is as follows:

April	2.07"
May	0.29"
June	2.14"
July	2.42"
August	2.22"
September	1.89"

This small amount of rainfall led to sparse growth in all the areas under observation regardless of the type of slope protection used. However, even this light rain caused some erosion problems on the slopes where the double-netted straw mat was used and severe problems where no erosion control was used. The most significant failures in the double-netted straw mat where rivulets of water had eroded under the mat and the water had washed the top soil out from under the mat and up to the surface of the mat.

In general the Soil Guard® sections had little discernable erosion occurring on the slopes. The amount of plant material that was growing in the Soil Guard® sections, however, appeared to have more weeds than what was found in the double-netted straw mats. It is not apparent if this was caused by not seeding the slopes prior to application of the Soil Guard® or if the incorporation of the seed into the Soil Guard® was the reason for this. The late fall and winter of 1996/1997 was drier than normal and that may have led to the seed contained within the Soil Guard® not having sufficient moisture to germinate.

The costs for this test site are as follows:

Contract Item	Quantity/Units	Cost per Unit	Total Cost
Straw Blanket	986.00 S.Y	$3.00 per S.Y.	$ 2,958.00
Soil Guard® Bonded Fiber Matrix	2,047.00 S.Y.	$1.85 per S.Y	$ 3,786.95
Conventional Seeding	537.00 S.Y.	$0.10 per S.Y	$ 53.70
Prime Contractor's Markup	553.96 Units	$1.00 per Unit	$ 553.96
Total Cost for Project			$7,352.61

Summary

The project was completed according to the plans with the exception that the seed was not broadcast but incorporated into the Soil guard®. Sections G, H, and I are double seeded, as it was not know at the time of installation of the soil guard that these sections had previously been seeded by a drill. The Section "I" Soil guard® was placed approximately six feet short of the top of the slope and the coverage of the section seems "light" as shown in Photo 2. Section I is on the right side of the photo.

The atmospheric conditions at the time of application were not ideal, given the wind speeds. However, the application of the Soil guard® appeared to adequately cover the soil, except in the aforementioned area "I".

As a part of this test section, an evaluation of the soil conditions and nutrients was performed. The test results indicate that NDDOT should consider revising the fertilizer specifications to area specific requirements instead of a standard application rate of fertilizer. It may be more prudent to require soil tests of top soil to determine the required fertilizer application.

Experimental sections were installed by change order at a cost of $7,352.61. The cost of the Soil Guard® Bonded Fiber Matrix, for this project was $1.85 per S.Y. whereas the double netted straw blanket was $3.00 per S. Y. If the use of Soil Guard® promotes similar or better plant growth than the straw blanket and the costs remain the same, it would be prudent to utilize this product. The NDDOT specifications allow the use of this type of application on slopes greater than 3:1 or on areas too small to seed with a drill.

See the accompanying pictures for conditions at the site.

Photo - 13 A view from the bottom of the slope with the Double Netted Straw on the left, a narrow strip of uncovered soil in the center and the Soil Guard® on the right.

Photo - 14 A view from the top of the slope with the Double Netted Straw on the top of the picture, the narrow strip of uncovered soil in the center and the Soil Guard® on the bottom.

Photo - 15 Is a view of the slope where no slope protection was placed.

Photo - 16 A close-up of the Double - Netted Straw mat.

Photo - 17 A close - up of Soil Guard®.

Photo - 18 close up of the fiber material that makes up Soil Guard®.

Photo - 19 A view from the bottom of the slope with the Double Netted Straw on the right side of the picture and the Soil Guard® on the left side of the picture.

Photo - 20 A view from the side of the slope with the Soil Guard® on the left and the Double Netted Straw on the right or top of the picture.

RECOMMENDATION

Given the performance of the materials, despite the climatic conditions, and Soil Guard® costing $1.85/SY compared to the double-netted straw mat cost of $3.00/SY, it is recommended that Soil Guard® be used on steep slopes to control erosion, and that each project site have the soils tested for fertilizer needs specific to its location.

APPENDIX A

Weyerhaeuser
SOIL GUARD
ENGINEERED FIBER PRODUCTS
7001 396th Ave. SE • Snoqualmie, WA 98065-9903 • Tel: 1-800-443-9179 • Fax 206-924-7148

THE TOPOGRAPHIC INDEX GUIDE

The purpose of the Topographic Index Guide (TIG) is provide a more accurate estimate of the surface area to be treated with hydraulic applications. Using the TIG, designers and contractors can take into account surface conditions which will require an increase in hydraulic components in order to gain effective coverage at the rate of material specified.

Explanation of Effective Area/Effective Coverage

It is important to understand that although the ***effective area*** increases due to the greater accuracy in estimation using the TIG, the amount of hydraulic material applied per unit area remains the same. For example:

On a 5:1 slope of standard loam soil, a 3,000 lb per acre application of Soil Guard® is appropriate and effective coverage (See Table); however,

If that same 5:1 slope has been track-walked or furrowed, the surface area increases by 20%, requiring an additional 600 lbs per acre (3,600 total) of Soil Guard ® to achieve ***effective coverage*** (See Table).

Similarly, areas estimated from plan view will always be less than actual ***effective area*** if slope gradient is not taken into consideration. A 3:1 slope increases effective area needing treatment by 6%, a 2:1 slope by 12%, etc. (See Table).

Cumulative Impact: Using the TIG to Estimate Application Rates

As can be seen in the Table, the effects of slope gradient and surface texture are cumulative; in other words, the increase in surface area due to slope gradient is added to the increase in surface area due to a topographic factor. Some adjustment has been made in the estimates based on actual field trials.

Using the TIG is a simple, three-step process:

1. Estimate the slope gradient (i.e. 4:1, 3:1, 3:1 stepped, etc.) and find the appropriate category on the left side of the Table (**Adjustment for Slope**);
2. Find the texture condition which best describes the soil surface (i.e. Standard Loam, Chiseled, Sheeps-Foot Roller, etc. (**Topographic Factor**); then,
3. Where the **Adjustment for Slope** row intercepts the **Topographic Factor** column is the percentage increase in surface area (**in parentheses**) and the increased pounds of Soil Guard® required for effective coverage (**shown as #**).

Weyerhaeuser
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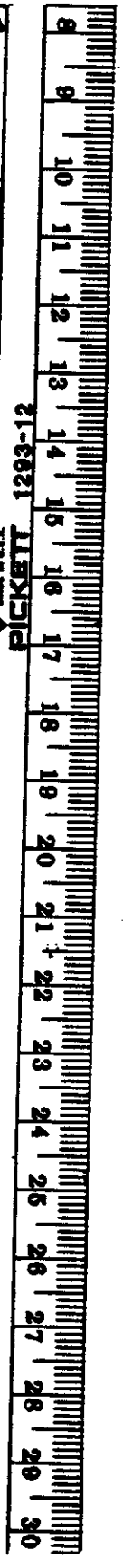

General Mixing/Capacities Reference Chart

Soil Guard® (50-lb bags)	Water (gals)	Mixture Volume (gals)	Ground Coverage (3,000 lbs/acre rate)	
			Sq Ft	Acres
1	125	133	725	0.017
2	250	266	1,450	0.033
3	375	399	2,175	0.050
4	500	532	2,900	0.067
5	625	665	3,625	0.083
6	750	798	4,350	0.100
7	875	931	5,075	0.116
8	1,000	1,064	5,800	0.133
9	1,125	1,197	6,525	0.150
10	1,250	1,330	7,250	0.166
11	1,375	1,463	7,975	0.183
12	1,500	1,596	8,700	0.200
13	1,625	1,729	9,425	0.216
14	1,750	1,862	10,150	0.233
15	1,875	1,995	10,875	0.250
16	2,000	2,128	11,600	0.266
17	2,125	2,261	12,325	0.283
18	2,250	2,394	13,050	0.300
19	2,375	2,527	13,775	0.316
20	2,500	2,660	14,500	0.333
21	2,625	2,793	15,225	0.350
22	2,750	2,926	15,950	0.366
23	2,875	3,059	16,675	0.383

SOIL TEST REPORT

SOIL TESTING LAB WALDRON HALL P.O. BOX 5575 NORTH DAKOTA STATE UNIVERSITY FARGO, ND 58105
Phone: (701)231-8882

RESEARCH SAMPLES

County: Burleigh

Copy To:

To: JEFF RICHTER
MATERIALS AND RESEARCH, NDDOT
300 AIRPORT ROAD
BISMARCK ND 58504

FIELD NUMBER :

SOIL NOTES :

Date Received: 11/22/96

Date Reported: 11/26/96

			SOIL TEST RESULTS														
Lab No.	Sample I.D.#	Depth (inches)	N	P	K	pH	EC	OM	S	Zn	Fe	Mn	Cu	Cl	Ca	Mg	Na
20,995	3	0- 6	39	4			0.42										
20,996	4	0- 6	30	4			0.38										
20,997	5	0- 6	45	8			0.45										
20,998	6	0- 6	37	5			0.44										
20,999	13	0- 6	45	5			0.50										
21,000	14	0- 6	38	3			0.41										
21,001	15	0- 6	63	5			0.46										
21,002	16	0- 6	53	5			0.45										

SOIL TESTING METHODS

pH in water; NO3-N(lb/acre/depth) extracted with water; OM(%) by ignition; P=Phosphorus, P(ppm) by 0.5M sodium bicarbonate; K=Potassium, K(ppm) by 1N ammonium acetate; soluble salts (EC - mmhos/cm) in 1:1 soil:water; Mn = Manganese; Zn,Fe,Cu, & Mn (ppm) by DTPA; SO4-S(lb/acre/depth) extracted with 500 ppm P as monobasic calcium phosphate; Cl (lb/acre/depth) extracted with 1N K2SO4.
Ca = Calcium, Mg = Magnesium, Na = Sodium, Ca(ppm), Mg(ppm), and Na(ppm) by 1N ammonium acetate.

TOPOGRAPHIC INDEX GUIDE

TOPOGRAPHIC FACTOR

ADJUSTMENT FOR SLOPE

	Standard Loam	High Silt	Non-Cohesive Sand	Loose Gravel (<2")	Chiseled or Disked	Medium Gravel (2-4")	Track-Walked or Furrow	Cobble (4-6")	Sheeps-Foot Roller
5:1 or Flatter	(0) #3,000	(10) #3,300	(10) #3,300	(15) #3,450	(15) #3,450	(20) #3,600	(20) #3,600	(25) #3,750	(25) #3,750
4:1	(3) #3,100	(12) #3,350	(12) #3,350	(17) #3,500	(17) #3,500	(21) #3,650	(21) #3,650	(27) #3,800	(27) #3,800
3:1	(6) #3,200	(15) #3,500	(15) #3,500	(20) #3,600	(20) #3,600	(25) #3,750	(25) #3,750	(30) #3,900	(30) #3,900
2:1	(12) #3,350	(18) #3,550	(18) #3,550	(25) #3,750	(25) #3,750	(30) #3,900	(30) #3,900	(35) #4,050	(35) #4,050
1.5:1	(20) #3,600	(20) #3,600	(20) #3,600	(30) #3,900	(30) #3,900	(35) #4,050	(35) #4,050	(40) #4,200	(40) #4,200
1:1	(40) #4,200 Split Applic.	(40) #4,200 Split Applic.	(40) #4,200 Split Applic.						
4:1 stepped	(20) #3,600								
3:1 stepped	(25) #3,750								
2:1 stepped	(35) #4,050								
1.5:1 stepped	(40) #4,200								
1:1 stepped	(40) #4,200								

(%) INCREASE and (#) POUNDS PER ACRE

Alfalfa

Table 23. Nutrient recommendations for alfalfa.

Yield goal	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a		lb P_2O_5/acre					lb K_2O/acre				
2		35	25	15	10	0	105	75	45	10	0
4		65	50	30	10	0	195	140	80	25	0
5		85	60	40	15	0	245	170	100	30	0
6		100	70	45	15	0	295	205	120	35	0

Bray-I P recommendation = (18.57-0.93 STP)YG
Olsen P recommendation = (18.57-1.16 STP)YG
Potassium recommendation = (55.71-0.38 STK)YG

Alsike Clover, Birdsfoot Trefoil, Red Clover and Grass-Legume

Table 24. Nutrient recommendations for alsike clover, birdsfoot trefoil, red clover and grass-legume.

Yield goal	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a		lb P_2O_5/acre					lb K_2O/acre				
2		35	25	15	0	0	95	65	40	15	0
3		55	40	25	10	0	140	100	60	20	0
4		70	50	30	10	0	185	135	80	25	0
5		90	65	40	15	0	230	165	100	35	0

Bray-I P recommendation = (20-STP)YG
Olsen P recommendation = (20-1.4 STP)YG
Potassium recommendation = (80.000-0.332 STK)YG

Established Grass, Native Grass, Irrigated Grass and New Seedings of Grass

Table 25. Nutrient recommendations for established grass, native grass, irrigated grass, and new seedings of grass.

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
2	50		40	20	10	0	0	70	50	25	0	0

Nitrogen recommendation = 25 YG-STN
Bray-I P recommendation = 45.0-2.5 STP
Olsen P recommendation = 45.00-3.45 STP
Potassium recommendation = 80.00-0.53 STK

SP-882

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3M-6-96

This publication will be made available in alternative formats for people with disabilities upon request, 701/231-7881.

APPENDIX B

JACKSON LANDSCAPE SUPPLY, INC.
10906 162nd STREET WEST ■ LAKEVILLE, MINNESOTA 55044 ■ PHONE: (612) 435-6927 ■ FAX: (612) 435-8718

January 27, 1997

North Dakota Department of Transportation
218 Airport Road
Bismarck, ND 58504

Attn: Steve Wolf

Dear Steve,

Enclosed you will find the information that you requested regarding the recent project at the Lincoln Memorial Battlefield completed last fall. The project number in reference is: 1806 Project #DPC-1-806-018-062.

The statement of compliance and the material safety data sheet which tells you the type of material and percentages that make up a bag of Soil Guard™. The material sprayed at the job site was 1,350 lbs of Soil Guard™. This amounts to 2,160.8 square yards of coverage or (.45 acre). The general contractor was Magic Mile Welding (Rick Kraemer) and the sub-contractor was S&B Landscape (Steve Becker & Monty Heinmeyer).

As a distributor, I can certify that the material sprayed on the jobsite on October 14th and 15th, 1996 was the material represented in these informational sheets. Please let me know if this is the type of information that you need to complete the project requirements. Thank you again for the opportunity to apply our product and I sincerely hope your department will be as pleased with its results as we are. I will look forward to speaking with you if you have any questions regarding any of the information I have sent.

Sincerely,

J. L. Hildebrand

Enclosures

JACKSON LANDSCAPE SUPPLY, INC.
10906 162nd STREET WEST ■ LAKEVILLE, MINNESOTA 55044 ■ PHONE: (612) 435-6927 ■ FAX: (612) 435-8718

Sample of possible Bonded Fiber Matrix Specification:

The bonded fiber matrix shall be a hydraulically applied system for long strand fibers joined together by a high strength adhesive to create a continuous three dimensional blanket that adheres to the soil surface. The system shall be applied to the soil a s a viscous mixture, which upon drying, creates a high strength, porous and erosion resistant mat. Upon drying the matrix shall not inhibit the germination and growth of plants beneath the layer. Upon drying, the bonded fiber matrix shall remain cohesive and bonded to the applied soil despite rewetting. Due to the unique nature of this product, its application in projects may be dictated by special provisions. The application rate may vary from 3000 to 4200 pounds per acre according to soil type and slope gradient. Soil Guard, manufactured by the Weyerhaeuser Corporation, is an example of the Bonded Fiber Matrix mentioned in this specification.

Weyerhaeuser

Corporate Headquarters
Tacoma WA 98477
Tel (206) 924 2345

CERTIFICATE OF COMPLIANCE
SOIL GUARD® EROSION CONTROL SYSTEM

Weyerhaeuser certifies that SOIL GUARD® has the properties and characteristics outlined below.

SOIL GUARD® is a bonded fiber matrix produced by Weyerhaeuser from 100% wood fiber with an added binder for increased erosion control. SOIL GUARD® is manufactured to contain a specified range of fiber lengths, with a minimum of 25% of the fibers averaging .4 inches long and with 50% or more retained on a Clark Fiber Classifier 24-mesh screen (a wet screening classification of fiber length). Weyerhaeuser packages SOIL GUARD® in durable 50 pound plastic or paper bags measuring 9"x18"x36".

SOIL GUARD® disperses rapidly in water and remains in uniform suspension under agitation. It blends with seed, fertilizer, and other approved and specified materials form a homogenous slurry. When applied with hydraulic planting equipment, the fibers form a continuous and strong moister-holding mat.

The binder is formulated from three elements:

1. A polysaccharide guar, commonly used in the erosion control industry
2. A standard agricultural fertilizer
3. A slow release fertilizer

The binder provides added bonding among the fibers to hold soil, seed, and fertilizer in place for rapid germination and growth. Upon drying the binder becomes water insoluble and remains biodegradable, creating an effective erosion control blanket.

The fibers are colored yellow with a water-soluble, no-toxic dye to help the operator apply SOIL GUARD® uniformly.

SOIL GUARD® is fully biodegradable and non-toxic. The material enriches the soil as it degrades and leaves no residues. It is safe for the environment and wildlife.

SOIL GUARD® has been evaluated at the Weyerhaeuser Technology Center, Federal Way, Washington. Product properties are determined using test methods that are scientifically sound and reliable to the best of our knowledge. Other test methods may produce slightly different results.

Weyerhaeuser Representative

Manufacturer Name and Address:
Weyerhaeuser Company
Tacoma WA 98477
Emergency Phone: (206) 924-5000
Additional Information: (206) 924-3865

Material Safety Data Sheet

Soil Guard

1 Product Identification

Product	Manufacturing Location
Soil Guard	Snoqualmie, WA

Synonyms: Bonded Fiber Matrix
Date Prepared: 07/02/93
Date Revised: 12/30/93
Prepared by: Corporate Safety & Health

2 Hazardous Ingredients/Identity Information

Chemical or Common Name CAS#	Percent	Exposure Limits		
* Wood CAS# None	>99	OSHA PEL-TWA OSHA PEL-STEL ACGIH TLV-TWA ACGIH TLV-STEL ACGIH TLV-TWA	5 mg/m³ 10 mg/m³ 5 mg/m³ 10 mg/m³ 1 mg/m³	(a) (a) (b) (b) (c)
Yellow 45L (Methine dye) CAS# Proprietary	<1	OSHA PEL-TWA ACGIH TLV-TWA	None None	
Polysaccharide Powdered Tackifier (Guar Gum) CAS# None	10	OSHA PEL-TWA ACGIH TLV-TWA	None None	
Trade Secret CAS# Proprietary	<1	OSHA PEL-TWA ACGIH TLV-TWA	None None	
Trade Secret CAS# Proprietary	<1	OSHA PEL-TWA ACGIH TLV-TWA	None None	

* Based on 1989 OSHA Permissible Exposure Limits (PEL) rule
(a) softwood or hardwood total dust
(b) softwood total dust
(c) selected hardwood total dust (beech, oak, others)

Appearance and Odor:
Dyed, yellow wood fiber with slight, woody odor. The wood component consists mainly of alder.

3 Physical/Chemical Characteristics

BOILING POINT (@ 760 mm Hg):	NAP
VAPOR PRESSURE (mm Hg):	NAP
VAPOR DENSITY (Air=1; 1 atm):	NAP
SPECIFIC GRAVITY (H_2O=1):	0.05 - 0.30
MELTING POINT:	NAP
EVAPORATION RATE (Butyl Acetate=1):	NAP
SOLUBILITY IN WATER (% by Weight):	ca. 10%
% VOLATILE BY VOLUME @ 70°F (21°C):	0

4 Fire and Explosion Hazard Data

Flash Point (Method Used): NAP
Flammable Limits:
LEL: See below under "Unusual Fire and Explosion Hazards"
UEL: NAP
Extinguishing Media:
Water, carbon dioxide, sand.
Autoignition Temperature (F or C): 400°F-500°F
Special Firefighting Procedures:
None.
Unusual Fire and Explosion Hazards:
Depending on moisture content, and more importantly, particle diameter, wood dust may explode in the presence of an ignition source. An airborne concentration of 40 grams (40,000 mg) of dust per cubic meter of air is often used as the LEL for wood dusts.

5 Reactivity Data

Stability:
( ) Unstable (x) Stable
Conditions to Avoid: NAP
Incompatibility (Materials to Avoid):
Avoid contact with oxidizing agents. Avoid open flame. Product may ignite at temperatures in excess of 400°F.
Hazardous Decomposition or By-Products:
Thermal decomposition products include carbon monoxide, carbon dioxide, aliphatic aldehydes, rosin acids, terpenes, and polycyclic aromatic hydrocarbons.
Hazardous Polymerization:
( ) May Occur (x) Will Not Occur

6 Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled:
Wood dust may be vacuumed or shoveled for recovery or disposal. Avoid dusty conditions and provide good ventilation. Use NIOSH/MSHA-approved respirator and goggles where ventilation is not possible.
Waste Disposal Method:
If disposed of or discarded in its purchased form, incineration is preferable. Dry land disposal is acceptable in most states. It is, however, the user's responsibility to determine at the time of disposal whether your product meets RCRA criteria for hazardous waste. Follow applicable federal, state and local regulations.
Precautions to be Taken in Handling and Storage:
No special handling precautions are required. Keep in cool, dry place away from open flame. The clear, water soluble packet contained inside the bail contains a chemical component that when heated, may release small quantities of formaldehyde gas. After blending bail with water, this hazard is minimized. Finished blended product contains less than 0.1% (0.000135%) free formaldehyde. Store in well ventilated area.
Other Precautions:
A NIOSH/MSHA-approved respirator and goggles should be worn when the allowable exposure limits may be exceeded.

7 Health Hazard Data

Primary Health Hazards:

The primary health hazard posed by this product is thought to be due to inhaling wood dust. However, handling material inside the water soluble packet contained inside the bail may result in exposure to free gaseous formaldehyde.

Primary Route(s) of Exposure:

( ) Ingestion:
(x) Skin: Dust
(x) Inhalation: Dust or gas

Acute Health Hazards – Signs and Symptoms of Exposure/ Emergency and First-Aid Procedures:

INGESTION: Not applicable under normal use.

EYE CONTACT: A component inside the water soluble packet contained inside bail may cause temporary irritation or a temporary burning sensation. Wood dust may cause mechanical irritation. Treat dust in eye as foreign object. Flush with water to remove dust particle. Get medical help if irritation persists.

SKIN CONTACT: A component inside the water soluble packet contained inside bail may cause allergic contact dermatitis in sensitized individuals resulting in redness, itching, and occasionally hives. Wood dust(s) of certain species may elicit allergic contact dermatitis in sensitized individuals as well, in addition to mechanical irritation. These products may be irritating to the skin from drying or mechanical abrasion experienced during frequent handling. Get medical help if rash, irritation, or dermatitis persists.

SKIN ABSORPTION: Not known to occur under normal use.

INHALATION: A component inside the water soluble packet contained inside bail may cause temporary irritation to the nose and throat. Wood dust may cause unpleasant deposit/obstruction in the nasal passages, resulting in dryness of nose, dry cough, and headaches. Remove to fresh air. Get medical help if persistent irritation, severe coughing, or breathing difficulty occurs.

Medical Conditions Generally Aggravated by Exposure:

Gaseous formaldehyde or wood dust may aggravate preexisting respiratory conditions or allergies.

Chronic Health Hazards:

Wood dust(s), depending on the species, may cause allergic contact dermatitis with prolonged, repetitive contact, and respiratory sensitization after prolonged exposure to elevated dust levels.

Carcinogenicity Listing:

( ) NTP: Not listed
( ) IARC Monographs: Not listed
( ) OSHA Regulated: Not listed

Gaseous formaldehyde has been shown to cause cancer in certain laboratory animals after long-term exposure to very high concentrations (14+ ppm), far above those normally found in the workplace with this product. Wood dust has been alleged to cause nasal/ paranasal sinus cancer (certain European hardwoods: oak and beech).

8 Control Measures

Personal Protective Equipment:

RESPIRATORY PROTECTION – A NIOSH/MSHA-approved respirator is recommended when allowable exposure limits may be exceeded.

PROTECTIVE GLOVES – Not required. However, cloth, canvas or leather gloves are recommended to minimize potential mechanical irritation from handling product.

EYE PROTECTION – Not applicable for product in purchased form. Goggles or safety glasses are recommended when mixing this product and in areas with high dust levels.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT – Not applicable for product in purchased form. Outer garments may be desirable in extremely dusty areas.

WORK/HYGIENE PRACTICES – Follow good hygienic and housekeeping practices. Clean up areas where wood dust settles to avoid excessive accumulation of this combustible material. Minimize blowdown or other practices that generate high airborne-dust concentrations.

Ventilation:

LOCAL EXHAUST – Provide local exhaust as needed so that exposure limits are met.

MECHANICAL (GENERAL) – Provide general ventilation in processing and storage areas so that exposure limits are met.

SPECIAL – Self-contained breathing apparatus (SCBA) recommended when fighting fire.

OTHER – NAP

9 Transportation Data

DOT Proper Shipping Name: Not Regulated
Hazard Class/Division Number:
ID Number:
Packing Group:
Label/Placard Required:
DOT Hazardous Substance:

10 User's Responsibility

The information contained in this Material Safety Data Sheet is based on the experience of occupational health and safety professionals and comes from sources believed to be accurate or otherwise technically correct. It is the user's responsibility to determine if this information is suitable for their applications and to follow safety precautions as may be necessary. The user has the responsibility to make sure that this sheet is the most up-to-date issue.

11 Additional Information

Definition of Common Terms:

ACGIH = American Conference of Governmental Industrial Hygienists
C = Ceiling Limit
CAS# = Chemical Abstracts System Number
IARC = International Agency for Research on Cancer
MSHA = Mining Safety and Health Administration
NAP = Not Applicable
NAV = Not Available
NIOSH = National Institute for Occupational Safety and Health
NTP = National Toxicology Program
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit
STEL = Short-Term Exposure Limit (15 minutes)
TLV = Threshold Limit Value
TWA = Time-Weighted Average (8 hours)