APPENDIX G – DUST CONTROL CATEGORY SELECTION PROCESS

Traditionally, to identify an acceptable dust control or roadway stabilization product the process has been based on a perspective that examines its specific and individual acceptability or suitability for the application. Products that have been used in the past with a known positive history are given more consideration than those that have not been used. Anecdotal experiences shared by trusted associates of success or failures more often contribute to the decision to use a product rather than fact sheets and promotional brochures offered by manufacturers and distributors. One misapplication can create a dark cloud over a product that ten successful applications cannot dispel.

The fact is that not every product works for all situations. Some products do have a broad range of effectiveness while others are have narrow applicability. Misapplications can result in slippery surfaces, lack of uniform mixing, continued instability and dusting, loss of product in the ditches, complaints from the public and mis-spent funds. Managers of unsurfaced roadways want to be able to confidently select an effective product, know that it is cost effective, and never have a failure. The USFS report *Dust Palliative Selection and Application Guide*(6) tabulates the effectiveness of dust palliative categories as shown in Table 25.

Table 25. Product selection chart. (USFS)

	Traffic Volumes, Average Daily Traffic			Surface Material								Climate During Traffic		
				Plasticity Index			Fines (Passing 75μm, No. 200, Sieve)							
Dust Palliative	Light <100	Medium 100 to 250	Heavy >250 (1)	<3	3–8	>8	<5	5–10	10–20	20–30	>30	Wet &/or Rainy	Damp to Dry	Dry (2)
Calcium Chloride	✓✓	✓✓	✓	✗	✓	✓✓	✗	✓	✓✓	✓	✗ (3)	✗ (3,4)	✓✓	✗
Magnesium Chloride	✓✓	✓✓	✓	✗	✓	✓✓	✗	✓	✓✓	✓	✗ (3)	✗ (3,4)	✓✓	✓
Petroleum	✓	✓	✓	✓✓	✓	✗	✓ (5)	✓	✓ (6)	✗	✗	✓ (3)	✓✓	✓
Lignin	✓✓	✓✓	✓	✗	✓	✓✓ (6)	✗	✓	✓✓	✓✓	✓ (3,6)	✗ (4)	✓✓	✓✓
Tall Oil	✓✓	✓	✗	✓✓	✓	✗	✗	✓	✓✓ (6)	✓ (6)	✗	✓	✓✓	✓✓
Vegetable Oils	✓	✗	✗	✓	✓	✓	✗	✓	✓	✗	✗	✗	✓	✓
Electro-chemical	✓✓	✓	✓	✗	✓	✓✓	✗	✓	✓✓	✓✓	✓✓	✓ (3,4)	✓	✓
Synthetic Polymers	✓✓	✓	✗	✓✓	✓	✗	✗	✓✓	✓✓ (6)	✗	✗	✓	✓✓	✓✓
Clay Additives (6)	✓✓	✓	✗	✓✓	✓✓	✓	✓✓	✓	✓	✗	✗	✗ (3)	✓	✓✓

Legend

✓✓ = Good ✓ = Fair ✗ = Poor

Notes:

(1) May require higher or more frequent application rates, especially with high truck volumes
(2) Greater than 20 days with less than 40% relative humidity
(3) May become slippery in wet weather
(4) SS-1 or CSS-1 with only clean, open-graded aggregate
(6) Road mix for best results

While this table has been a standard reference since it was published in 1999, there is a need to reexamine the selection process from the perspective of not whether a category will work for a specific site, but what categories will work for a particular site. Therefore, the following process is proposed that prioritizes the families of dust palliative categories based on the conditions of traffic, climate, plasticity index, percent fines, environmental impact, cost, and application rate.

Step 1: The initial USFS list shown in Table 25 was expanded to include all of the families of products, plus Environmental Impact, Relative Cost and Application Rate.

Step 2: Numerical values of 1, 2, or 3 were assigned to each of the site condition attributes representing good, fair, or poor product performance; or low, medium, or high impact or cost. This new and expanded information is shown in Table 26. For easier visualization, green was associated with "1", yellow with "2", and pink with "3".

One can easily see that some products may be effective for a specific climate, but not effective for a specific level of traffic, while others are effective for both. Similar observations can be seen for the material attributes. Therefore, it was necessary to "optimize" each product's effectiveness for all of the attributes.

Step 3: For each of the 17 families of products, the numerical values associated with the three climate conditions and the three traffic levels were multiplied and sorted from low to high to produce Table 27. Similarly, the numerical values associated with the three plasticity index values and the five percent fines amounts were multiplied and sorted from low to high to produce Table 28.

Note that in these tables, a value of "1" represents a product that would be highly recommended for a particular combination of attributes, whereas a "9" would not. One can see for instance in Table 27 that there are six families of products with a value of "1" for a Dry Climate and a Light Traffic. On the other hand in that same Table 27 for a Wet or Rainy Climate and a Heavy Traffic there are no highly recommended products with a value of "1". Instead the best options are four products with a value of "4", indicating they may work, but not to the full level desired.

Step 4: For each of the 17 families of products, the numerical values associated with the six environmental impacts, cost, and application rates were averaged and sorted from low to high to produce an Overall Cost Factor in Table 29.

Up to this point, no calculations have been necessary for a person selecting a product for their specific site, however for the next steps it will be required when the calculated values for the traffic levels and climate are combined with those for the plasticity index and percent fines, and the overall cost factor.

Step 5: Select the particular blocks from Tables 27 and 28 along with the Overall Cost Factor block that show the 17 family of products associated with the specific site conditions, and average and sort their values from low to high. The products with the lowest values are recommended as best optimized for use based on all of the combined conditions.

Table 26. Expanded and revised product selection chart.

Family	Product	Climate			Traffic ADT			Material								Environmental Impact						Relative Cost	Application Rate
		Wet or Rainy	Damp to Dry	Dry	Light <100	Medium 100 to 250	Heavy >250	Plasticity Inde1			% Fines -#200					Stability (No Leach)	Surface Water (No Harm)	Ground Water (No Harm)	Plants (No Harm)	Animals (No Harm)	Humans (No Harm)		
								<3	3-8	>8	<5	5-10	10-20	20-30	>30								
Water	water	3	1	2	1	2	3	2	2	1	2	1	1	1	2	3	1	1	1	1	1	1	3
Water Absorbing	calcium chloride	3	1	3	1	1	2	3	2	1	3	2	1	2	3	3	2	2	2	2	2	2	3
	magnesium chloride	3	1	2	1	1	2	3	2	1	3	2	1	2	3	3	2	2	2	2	2	2	3
	sodium chloride	3	2	3	1	2	2	3	2	2	3	2	1	2	3	3	2	2	2	2	2	2	3
Organic Petroleum	asphalt emulsions	2	1	2	2	2	2	1	2	3	1	2	2	3	3	3	3	3	3	2	2	3	3
	cutback asphalt	2	1	2	2	2	2	1	2	3	1	2	2	3	3	3	3	3	3	2	2	3	3
	dust oil	2	1	2	2	2	2	1	2	3	1	2	2	3	3	3	3	3	3	2	2	3	3
	modified AC emulsions	2	1	2	2	2	2	1	2	3	1	2	2	3	3	3	3	3	3	2	2	3	3
Organic Non-Petroleum	animal fats	3	2	3	2	3	3	2	2	2	3	3	2	3	3	3	3	3	1	1	2	2	3
	lignosulfonate	3	1	1	1	1	2	3	2	1	3	2	1	1	2	2	2	2	2	2	2	2	3
	molasses sugar beet	3	2	2	2	3	3	2	2	2	3	2	2	3	3	3	1	1	1	1	1	3	3
	tall oil emulsions	2	1	1	1	2	3	1	2	3	3	2	1	2	3	3	2	2	2	2	2	2	3
	vegetable oils	3	2	2	2	3	3	2	2	2	3	2	2	3	3	3	1	1	1	1	1	2	3
Electrochemical	enzymes	2	2	2	1	2	2	3	2	1	3	2	1	1	1	2	2	2	1	1	1	1	1
	ionic	2	2	2	1	2	2	3	2	1	3	2	1	1	1	2	2	2	1	1	1	2	1
	sulphonated oils	2	2	2	1	2	2	3	2	1	3	2	1	1	1	2	2	2	1	1	1	2	1
Synthetic Polymer	polyvinyl acetate	2	1	1	1	2	3	1	2	3	3	1	1	3	3	1	2	2	1	1	1	3	2
	vinyl acrylic	2	1	1	1	2	3	1	2	3	3	1	1	3	3	1	2	2	1	1	1	3	2
Clay Addititves	bentonite	3	2	1	1	2	3	1	1	2	1	2	2	3	3	1	2	1	1	1	1	2	2
	montmorillonite	3	2	1	1	2	3	1	1	2	1	2	2	3	3	1	2	1	1	1	1	2	2

Table 27. Traffic level versus climate conditions product ranking.

TRAFFIC ADT		Wet or Rainy		Damp to Dry		Dry	
		CLIMATE					
	Heavy >250	organic petroleum	4	calcium chloride	2	lignosulfonate	2
		enzymes	4	magnesium chloride	2	tall oil	3
		ionic	4	organic petroleum	2	polyvinyl acetate	3
		sulphonated oils	4	lignosulfonate	2	vinyl acylic	3
		calcium chloride	6	water	3	bentonite	3
		magnesium chloride	6	tall oil	3	montmorillonite	3
		sodium chloride	6	polyvinyl acetate	3	magnesium chloride	4
		lignosulfonate	6	vinyl acylic	3	organic petroleum	4
		tall oil	6	sodium chloride	4	enzymes	4
		polyvinyl acetate	6	enzymes	4	ionic	4
		vinyl acylic	6	ionic	4	sulphonated oils	4
		water	9	sulphonated oils	4	water	6
		animal fat	9	animal fat	6	calcium chloride	6
		molasses/sugar beets	9	molasses/sugar beets	6	sodium chloride	6
		vegetable oil	9	vegetable oil	6	molasses/sugar beets	6
		bentonite	9	bentonite	6	vegetable oil	6
		montmorillonite	9	montmorillonite	6	animal fat	9
	Medium 100 to 250	calcium chloride	3	calcium chloride	1	lignosulfonate	1
		magnesium chloride	3	magnesium chloride	1	magnesium chloride	2
		lignosulfonate	3	lignosulfonate	1	tall oil	2
		organic petroleum	4	water	2	polyvinyl acetate	2
		tall oil	4	organic petroleum	2	vinyl acylic	2
		enzymes	4	tall oil	2	bentonite	2
		ionic	4	polyvinyl acetate	2	montmorillonite	2
		sulphonated oils	4	vinyl acylic	2	calcium chloride	3
		polyvinyl acetate	4	sodium chloride	4	water	4
		vinyl acylic	4	enzymes	4	organic petroleum	4
		water	6	ionic	4	enzymes	4
		sodium chloride	6	sulphonated oils	4	ionic	4
		bentonite	6	bentonite	4	sulphonated oils	4
		montmorillonite	6	montmorillonite	4	sodium chloride	6
		animal fat	9	animal fat	6	molasses/sugar beets	6
		molasses/sugar beets	9	molasses/sugar beets	6	vegetable oil	6
		vegetable oil	9	vegetable oil	6	animal fat	9
	Light <100	tall oil	2	water	1	lignosulfonate	1
		enzymes	2	calcium chloride	1	tall oil	1
		ionic	2	magnesium chloride	1	polyvinyl acetate	1
		sulphonated oils	2	lignosulfonate	1	vinyl acylic	1
		polyvinyl acetate	2	tall oil	1	bentonite	1
		vinyl acylic	2	polyvinyl acetate	1	montmorillonite	1
		water	3	vinyl acylic	1	water	2
		calcium chloride	3	sodium chloride	2	magnesium chloride	2
		magnesium chloride	3	organic petroleum	2	enzymes	2
		sodium chloride	3	enzymes	2	ionic	2
		lignosulfonate	3	ionic	2	sulphonated oils	2
		bentonite	3	sulphonated oils	2	calcium chloride	3
		montmorillonite	3	bentonite	2	sodium chloride	3
		organic petroleum	4	montmorillonite	2	organic petroleum	4
		animal fat	6	animal fat	4	molasses/sugar beets	4
		molasses/sugar beets	6	molasses/sugar beets	4	vegetable oil	4
		vegetable oil	6	vegetable oil	4	animal fat	6

Table 28. Plasticity index versus percent minus #200 product ranking.

PLASTICITY INDEX (PI)											
	>8	water	2	water	1	water	1	water	1	enzymes	1
		bentonite	2	calcium chloride	2	calcium chloride	1	lignosulfonate	1	ionic	1
		montmorillonite	2	magnesium chloride	2	magnesium chloride	1	enzymes	1	sulphonated oils	1
		calcium chloride	3	lignosulfonate	2	lignosulfonate	1	ionic	1	water	2
		magnesium chloride	3	enzymes	2	enzymes	1	sulphonated oils	1	lignosulfonate	2
		organic petroleum	3	ionic	2	ionic	1	calcium chloride	2	calcium chloride	3
		lignosulfonate	3	sulphonated oils	2	sulphonated oils	1	magnesium chloride	2	magnesium chloride	3
		enzymes	3	polyvinyl acetate	3	sodium chloride	2	sodium chloride	4	sodium chloride	6
		ionic	3	vinyl acylic	3	tall oil	3	animal fat	6	animal fat	6
		sulphonated oils	3	sodium chloride	4	polyvinyl acetate	3	molasses/sugar beets	6	molasses/sugar beets	6
		sodium chloride	6	molasses/sugar beets	4	vinyl acylic	3	tall oil	6	vegetable oil	6
		animal fat	6	vegetable oil	4	animal fat	4	vegetable oil	6	bentonite	6
		molasses/sugar beets	6	bentonite	4	molasses/sugar beets	4	bentonite	6	montmorillonite	6
		vegetable oil	6	montmorillonite	4	vegetable oil	4	montmorillonite	6	organic petroleum	9
		tall oil	9	organic petroleum	6	bentonite	4	organic petroleum	9	tall oil	9
		polyvinyl acetate	9	animal fat	6	montmorillonite	4	polyvinyl acetate	9	polyvinyl acetate	9
		vinyl acylic	9	tall oil	6	organic petroleum	6	vinyl acylic	9	vinyl acylic	9
	3 - 8	bentonite	1	water	2	water	2	water	2	enzymes	2
		montmorillonite	1	polyvinyl acetate	2	calcium chloride	2	lignosulfonate	2	ionic	2
		organic petroleum	2	vinyl acylic	2	magnesium chloride	2	enzymes	2	sulphonated oils	2
		water	4	bentonite	2	sodium chloride	2	ionic	2	bentonite	3
		calcium chloride	6	montmorillonite	2	lignosulfonate	2	sulphonated oils	2	montmorillonite	3
		magnesium chloride	6	calcium chloride	4	tall oil	2	bentonite	3	water	4
		sodium chloride	6	magnesium chloride	4	enzymes	2	montmorillonite	3	lignosulfonate	4
		animal fat	6	sodium chloride	4	ionic	2	calcium chloride	4	calcium chloride	6
		lignosulfonate	6	organic petroleum	4	sulphonated oils	2	magnesium chloride	4	magnesium chloride	6
		molasses/sugar beets	6	lignosulfonate	4	polyvinyl acetate	2	sodium chloride	4	sodium chloride	6
		tall oil	6	molasses/sugar beets	4	vinyl acylic	2	tall oil	4	organic petroleum	6
		vegetable oil	6	tall oil	4	bentonite	2	organic petroleum	6	animal fat	6
		enzymes	6	vegetable oil	4	montmorillonite	2	animal fat	6	molasses/sugar beets	6
		ionic	6	enzymes	4	organic petroleum	4	molasses/sugar beets	6	tall oil	6
		sulphonated oils	6	ionic	4	animal fat	4	vegetable oil	6	vegetable oil	6
		polyvinyl acetate	6	sulphonated oils	4	molasses/sugar beets	4	polyvinyl acetate	6	polyvinyl acetate	6
		vinyl acylic	6	animal fat	6	vegetable oil	4	vinyl acylic	6	vinyl acylic	6
	<3	organic petroleum	1	polyvinyl acetate	1	tall oil	1	water	2	organic petroleum	3
		bentonite	1	vinyl acylic	1	polyvinyl acetate	1	tall oil	2	tall oil	3
		montmorillonite	1	water	2	vinyl acylic	1	organic petroleum	3	enzymes	3
		tall oil	3	organic petroleum	2	water	2	lignosulfonate	3	ionic	3
		polyvinyl acetate	3	tall oil	2	organic petroleum	2	enzymes	3	sulphonated oils	3
		vinyl acylic	3	bentonite	2	bentonite	2	ionic	3	polyvinyl acetate	3
		water	4	montmorillonite	2	montmorillonite	2	sulphonated oils	3	vinyl acylic	3
		animal fat	6	molasses/sugar beets	4	calcium chloride	3	polyvinyl acetate	3	bentonite	3
		molasses/sugar beets	6	vegetable oil	4	magnesium chloride	3	vinyl acylic	3	montmorillonite	3
		vegetable oil	6	calcium chloride	6	sodium chloride	3	bentonite	3	water	4
		calcium chloride	9	magnesium chloride	6	lignosulfonate	3	montmorillonite	3	animal fat	6
		magnesium chloride	9	sodium chloride	6	enzymes	3	calcium chloride	6	lignosulfonate	6
		sodium chloride	9	animal fat	6	ionic	3	magnesium chloride	6	molasses/sugar beets	6
		lignosulfonate	9	lignosulfonate	6	sulphonated oils	3	sodium chloride	6	vegetable oil	6
		enzymes	9	enzymes	6	animal fat	4	animal fat	6	calcium chloride	9
		ionic	9	ionic	6	molasses/sugar beets	4	molasses/sugar beets	6	magnesium chloride	9
		sulphonated oils	9	sulphonated oils	6	vegetable oil	4	vegetable oil	6	sodium chloride	9
		<5		5 - 10		10 - 20		20 - 30		>30	
		% - #200									

Table 29. Environmental, cost, and application rate product ranking.

Sorted by Overall Cost Factor								
	bentonite	1	bentonite	2	bentonite	2	bentonite	2
	montmorillonite	1	montmorillonite	2	montmorillonite	2	montmorillonite	2
	polyvinyl acetate	1	polyvinyl acetate	3	polyvinyl acetate	2	polyvinyl acetate	2
	vinyl acylic	1	vinyl acylic	3	vinyl acylic	2	vinyl acylic	2
	enzymes	3	enzymes	1	enzymes	1	enzymes	2
	ionic	3	ionic	2	ionic	1	ionic	2
	sulphonated oils	3	sulphonated oils	2	sulphonated oils	1	sulphonated oils	2
	water	3	water	1	water	3	water	2
	vegetable oil	3	vegetable oil	2	vegetable oil	3	vegetable oil	3
	molasses/sugar beets	3	molasses/sugar beets	3	molasses/sugar beets	3	molasses/sugar beets	3
	lignosulfonate	4	lignosulfonate	2	lignosulfonate	3	lignosulfonate	3
	calcium chloride	6	calcium chloride	2	calcium chloride	3	calcium chloride	4
	magnesium chloride	6	magnesium chloride	2	magnesium chloride	3	magnesium chloride	4
	sodium chloride	6	sodium chloride	2	sodium chloride	3	sodium chloride	4
	animal fat	6	animal fat	2	animal fat	3	animal fat	4
	tall oil	6	tall oil	2	tall oil	3	tall oil	4
	organic petroleum	8	organic petroleum	3	organic petroleum	3	organic petroleum	5
	Environmental Factor		Relative Cost		Application Rate		Overall Cost Factor	

The results of an example are shown in Table 30 using this Seedskadee study's specific site conditions of:

Traffic Level: Light (10 to 15 ADT)
Climate: Dry
PI: 3 – 8 (actual was 4)
Percent -#200: 1 – 20 (actual was 12).

Table 30. Seedskadee NWR specific site product ranking recommendations.

Seedskadee National Wildlife Refuge Study										
	polyvinyl acetate	1	polyvinyl acetate	2	polyvinyl acetate	2	polyvinyl acetate	2	polyvinyl acetate	3
	vinyl acylic	1	vinyl acylic	2	vinyl acylic	2	vinyl acylic	2	vinyl acylic	
	bentonite	1	bentonite	2	bentonite	2	bentonite	2	bentonite	
	montmorillonite	1	montmorillonite	2	montmorillonite	2	montmorillonite	2	montmorillonite	
	water	2	water	2	water	2	water	2	water	
	lignosulfonate	1	lignosulfonate	2	lignosulfonate	3	lignosulfonate	2	lignosulfonate	1
	enzymes	2	enzymes	2	enzymes	2	enzymes	2	enzymes	2
	ionic	2	ionic	2	ionic	2	ionic	2	ionic	
	sulphonated oils	2	sulphonated oils	2	sulphonated oils	2	sulphonated oils	2	sulphonated oils	
	tall oil	1	tall oil	2	tall oil	4	tall oil	2	tall oil	
	magnesium chloride	2	magnesium chloride	2	magnesium chloride	4	magnesium chloride	3	magnesium chloride	1
	calcium chloride	3	calcium chloride	2	calcium chloride	4	calcium chloride	3	calcium chloride	
	sodium chloride	3	sodium chloride	2	sodium chloride	4	sodium chloride	3	sodium chloride	
	molasses/sugar beets	4	molasses/sugar beets	4	molasses/sugar beets	3	molasses/sugar beets	4	molasses/sugar beets	
	vegetable oil	4	vegetable oil	4	vegetable oil	3	vegetable oil	4	vegetable oil	2
	organic petroleum	4	organic petroleum	4	organic petroleum	5	organic petroleum	4	organic petroleum	
	animal fat	6	animal fat	4	animal fat	4	animal fat	5	animal fat	
	Traffic vs Climate		PI vs %-#200		Environmental-Cost-Rates		Recommended Products		Actual Study Ranking	

One can see that further development is still needed since the products recommended under this optimizations selection process do not track well with the actual observed product performance. The process appears to be sound, but the initial numerical values in Table 26 may need to be revisited and revised as more information of product performance is documented.