Dust Suppressant Test in the Hieroglyphic Mountains northwest of Phoenix, Arizona.

Conducted by BLM Phoenix District
with support from USFS Recreation Solutions Enterprise Team,
Maricopa County Environmental Quality
and Arizona Off-Highway Vehicle Coalition

June, 2008

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Abstract:
Two liquid dust palliatives were tested by driving vehicles over treated test plots while a trained observer assessed the amount of dust generated. Observations were made periodically over a six month period. Data analysis was conducted to determine product effectiveness as compared to an untreated surface.

Executive Summary:

In 2007, a new Arizona state law requiring dust management within Maricopa County caused the county to promulgate new dust rules. To assist the county in achieving air quality goals, BLM conducted a test of two manufactured liquid dust suppressants. The test was funded by the Arizona State Parks Off-Highway Vehicle Fund. Two liquid dust suppressants were sprayed on an existing dirt road at the Boulders Staging and Camping Area northwest of Phoenix, Arizona. They were tested from December 2007 through May 2008.

The test was simple. BLM and contract staff drove a truck, ATV and motorcycle over the three 450ft test sections at predetermined speeds while a Maricopa County dust inspector judged the amount of dust created. A control, or untreated section, was used to evaluate the effectiveness of the Durasoil and Soiltac treatments as compared to bare soil.

The amount of dust generated, also measured as opacity, must be lower than a rating of twenty percent to pass county air quality standards. The test revealed that the suppressant named Durasoil™ worked very well, while the other, Soiltac™ did not. Durasoil works well due to its non-drying properties. This inert chemical looks and feels much like baby or mineral oil and can be sprayed like water onto dirt roads and trails.

Periodic tests were conducted over six months. The data was recorded and analyzed. Cost per vehicle pass was determined by extrapolating the expected vehicle counts over the application lifespan and dividing it into material cost. Durasoil was the lowest cost application. It calculates to $0.335 per vehicle trip mile for a truck. The cost goes down by half for an ATV ($0.168), and significantly down again for a motorcycle ($0.028). Soiltac cost is extremely high at $3.29 per vehicle trip mile for a truck, $0.66 for an ATV, and $0.22 for a motorcycle due to poor lifespan and high product cost.

Although these cost calculations are simplistic, the estimates offer a fiscal approach to an engineering solution which permits recreation, including OHV, in air quality sensitive areas. The statistical results from this study confirm that vehicle generated dust can be suppressed without daily watering.

The use of dust suppressants is a principal option in managing all uses within the dust boundary. This test was deemed successful and a follow up test is being scheduled to test other dust suppressants in an effort to find a lower cost solution comparable to Durasoil.

Special thanks are given to BLM's partners in conducting this test. Maricopa County Environmental Quality provided two dust inspectors for the duration of the test at no cost to BLM. Arizona Off-Highway Vehicle Coalition provided a qualified ATV operator with an ATV for the duration of the test.

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Purpose and need:

An area on Bureau of Land Management (BLM) land popular for off-highway vehicle use is within the air quality boundary for serious non-attainment of particulate matter smaller than ten microns, also known as PM-10. The intent of the PM10 boundary around the metro Phoenix, Arizona area is to improve air quality and overall citizen health. Furthermore, Maricopa County has promulgated rules 310 and 310.01 to manage blowing dust, also known as fugitive dust. To help Maricopa county meet air quality standards, BLM decided to conduct a test to determine if dust from passing vehicles can be reduced by spraying commercially available dust suppressants on dirt roads and trails.

Overall Goals:

1) Find a solution for reducing airborne dust caused by vehicle passage and blowing wind
2) Comply with Maricopa County's 20% opacity rule for fugitive dust on access roads and parking lots by ensuring vehicles create dust opacity of 20% or less.
3) Improve camping and riding experiences for recreationists
4) Positively contribute to citizen health
5) Determine baseline application lifespan and costs for workable solutions

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Test Parameters and experimental procedure:

Known / Given:

-A dusty road used as entry/exit route, to trails, at a popular off-highway vehicle staging area in a PM-10 serious non-attainment area.
-Soil type = Ebon very gravelly loam, 1 to 8 percent slopes, 5-10% clay, 0-4% silt
-Heavy vehicle use primarily on weekends, October 1- May 15
-Maricopa County Department of Environmental Quality (DEQ) stabilization tests (Opacity observation test method)
-Maricopa county dust inspectors available to conduct opacity method observations as described in Maricopa county rule 310.01, Appendix C, section 2 Test methods for stabilization.

Variables:

Durasoil™ liquid dust suppressant and the application rate on a light use road
Soiltac™ liquid dust suppressant and the application rate on a light use road
Three motor vehicles – truck, all-terrain vehicle (ATV), off-highway motorcycle
Weather conditions in Phoenix, Arizona in fall, winter and spring
Traffic level and type of use between test periods
Operator skill to keep tires from spinning on uneven terrain
Consistency of vehicle test speed
Availability of test vehicles to administer tests

Hypothesis:

-By applying a spray on dust palliative, dust emissions can be reduced to meet Maricopa county Department of Environmental Quality standards of less than 20% opacity.
-The length of time the dust palliative remains effective will depend upon the number and type of vehicle passes and the precipitation received. Other factors such as surface preparation and presence of spin turn marks may lessen the application's effective time.
-It is possible that the dust palliative's effectiveness will have a major drop off point based on number of vehicle counts or time.
-Receiving precipitation will have a positive effect or negative effect on effectiveness (i.e. reactivation may occur, or dispersal may occur)

Experimental Goals:

1) Determine the relationship between dust suppression and elapsed time – if effective time span is longer than test duration, extrapolate expected product lifespan
2) Determine relationship between application effectiveness and number of vehicle passes. Consider the severity of accumulated passes if possible.
3) Determine the opacity improvement of an application as compared to bare soil over time.
4) Determine cost per mile by vehicle type for all applications.

Equipment:

350gallon spray trailer (water buffalo) towed behind truck
PPE (Long pants/shirt, eye/foot protection, work gloves)
Wood stakes for road sections to be tested
Two active infrared vehicle counters, installed between control and test sections.

Dust measurement described in Maricopa County Fugitive Dust Test Methods manual (Rule 310)
1 Truck, 1 ATV, 1 dirt bike for testing

Methods:

Stake three 150yard sections with a minimum of 100yards separating each test section. See Appendix H for a layout map.

Apply the following treatments to the test sections:
1) Durasoil applied to unprepared soil surface (1gal Durasoil undiluted covers 30sqft, total 150gal)
2) SoilTac applied to unprepared soil surface (1 gal Soiltac diluted at 7:1 covers 70sqft, total 450gal)
3) No application – Control section

Apply the palliative on a Monday, Tuesday or Wednesday to allow it to set up as recommended (24hrs required). See Appendix C for specifications and MSDS sheets.

Install two vehicle counters. Locate a counter between Durasoil and SoilTac sections and between SoilTac and Control test sections. Active infrared counters will be used. Accumulated vehicle counts to be recorded before each test. See Appendix E for counter specifications.

Spray water on the test section approach, before the start of each evaluation, on the area between sections and test exit area to avoid fugitive dust from being carried into the test sections. Additionally, wait 10minutes for surface water to soak in such that mud is not tracked into test sections.

Drive (1) truck (20mph), (1) ATV (25mph), (1) dirt bike (30mph) over the test sections of road and measure airborne particulates for each individual vehicle. Repeat three times consecutively for each vehicle type, each test day. Allow the dust to settle between each of the consecutive trips. Use a Garmin GPS as a speedometer on vehicles that do not have one.

Timing - Conduct tests during the high use period between October 1 and May 15.

Test vehicles –2005 Ford F-250 4x4 (truck), 2007 Polaris Sportsman 500 (ATV). 2001 Suzuki DRZ 250 (Motorcycle)

Conduct Opacity test evaluations for fugitive dust evaluation using a qualified dust inspector

Record the data from Opacity test using the data collection form.

Record vehicle trip data from both vehicle counters

Record the weather conditions - current and looking back to the previous evaluation.

Test schedule

	Durasoil	SoilTac	Control
	Test interval begins 2 days after application		
Eval 1	12/6	(0wk)	(0wk)
Eval 2	12/13	(1wk)	(1wk)
Eval 3	12/20	(2wk)	(2wk)
Eval 4	1/3	(4wk)	(4wk)
Eval 5	1/17	(6wk)	(6wk)
Eval 6	1/31	(8wk)	(8wk)

Eval 7	2/14	(10wk)	(10wk)
Eval 8	2/28	(12wk)	(12wk)

Note: Test will be stopped early if both suppressants fail.

Test Extended based on good performance by Durasoil, available time and dry weather

Eval 9	3/25	N/A	(16wk)
Eval 10	4/22	N/A	(20wk)
Eval 11	5/20	N/A	(24wk)

Analysis of data:

Plot an X vs. Y graph of Opacity (percent) vs. test duration (days)
Plot an X vs. Y graph of Time (days) vs. Vehicle passes (counts)
Plot a bar graph of Opacity difference between Durasoil/Soiltac compared to control

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Results:

Summary

Product effectiveness:

Having tested two products against an untreated control area, it has been determined that Durasoil™ is an effective application to reduce fugitive dust from vehicles. Both Soiltac and Durasoil initially reduced dust opacity, but only Durasoil performed well throughout the entire test. Durasoil was effective for the six month duration of the test and showed low opacity at the end of the test indicating it would continue to work for another year. Soiltac™ was not effective beyond two months, thus making it unsuitable for widespread vehicle fugitive dust suppression. Analysis shows that reapplication cost and frequency make it cost prohibitive. The Durasoil test section opacity was reduced by at least 10-15% in most tests. It effectively cuts the dust generated in half. While there are many factors in dust generation, the data shows that the truck created the most dust on all test sections including the control, while the motorcycle created the least in all cases. Graphs in Appendix A show the results in detail.

Data Discussion:

This test occurred in the field where many variables were possible. Attempts were made to avoid unnatural variation by controlling several variables, namely the vehicle types and condition, speed, observers, and operators. Some data points raised question of their validity. The major data variations are discussed here.

One of the hypotheses was that there is a relationship between elapsed time and effectiveness. By taking data over time, the relationships could be determined by graphing. Opacity was expected to rise over time due to a variety of factors, yet it was never expected to decrease. An opacity decrease across all vehicle types was observed around 110days (Appendix A, Graph A1). There was no rain around this time, but there was a high wind advisory day which likely removed fine particles from all three test surfaces. Since this was a natural event, the data was retained. The opacity observation data could be deemed somewhat subjective since it is a visual observation except that there were two dust inspectors at most tests, and both inspectors noted similar opacity percentages on all days. Based on this, the observations were deemed reliable. Another notable observation is that the Durasoil section appeared to be increasing in surface compaction over the life of the test. It would appear that the non-drying properties allow for increased compaction and reduced dust generation.

Another hypothesis was that significant rainfall would either diminish or improve the performance of the dust suppressants. Only two days after the products were applied, almost two inches of steady rain fell. Rain continued to fall regularly throughout the first three months of the test, totaling 5.31 inches. Rain data is shown in Appendix F. When the ground dried out enough to make dust, tests were conducted on the scheduled test days. Since there was a control section, differences in opacity relative to soil moisture could be observed. Soil moisture content was not measured in this test. Product performance without rainfall may have produced different results. The test was originally scheduled for three months during the highest use season, but the data would have been more difficult to evaluate had the test been stopped at three months. Extending the test to six months allowed for more data points and the opportunity to see how Durasoil performed with more vehicle passes and extended dry weather. There was no measurable rainfall for the last three months of the test.

Some equipment and procedure variations are worth noting. During the test, the same equipment was used with relatively low wear showing on tires between tests. The vehicles were used occasionally between tests, so tire / knobby wear was minor, possibly insignificant. Pictures and vehicle specifications are shown in Appendix

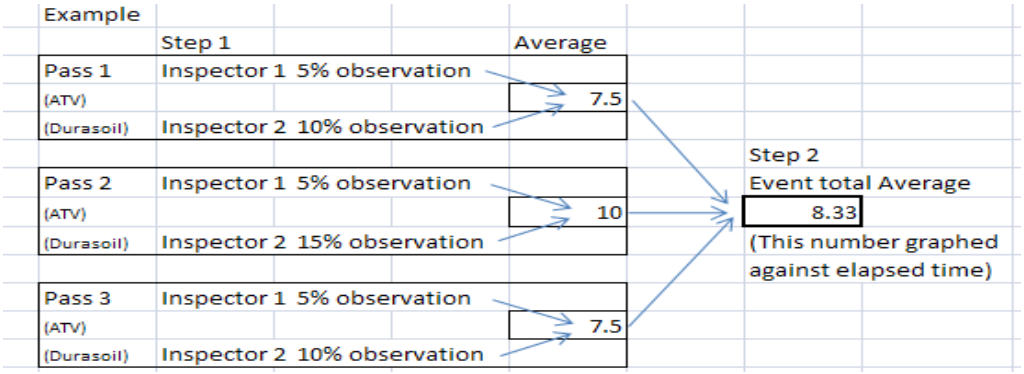
E. On one occasion, the Polaris ATV was unavailable so a similar design Honda was used. After reviewing the data from this day, the opacity observations were as comparable to previous tests, so the data was retained. On two occasions, only one dust inspector was available. The inspector making observations was an experienced person. The data appeared to be in line with other days and was retained.

Only one data point was thrown out. During one of the passes in the Soiltac section, the truck was driven onto the untreated road shoulder. The opacity spiked to 45%. Since we were attempting to test the Soiltac performance and not driving skills, this data point was thrown out. There were two other truck Soiltac passes that were retained on this day. Similarly, a Durasoil test using the truck showed high readings around 80 days. This data was retained because it fell under the 20% opacity limit and it was unclear as to the reason for the higher than usual reading. The observed opacity for the Durasoil section was the same as the control section. This was unexpected. One cause could be only one dust inspector was available and the opacity observations are made in 5% increments, making the difference between the data appear to be zero on paper. Rainfall had occurred only two weeks prior and number of vehicles passes only numbered about 4000 at the time.

Vehicle counter data was gathered in an attempt to determine how many passes the test sections were receiving in the highest use period of the year. The LP6 road is the main exit route to trails from the newly constructed Boulders Staging and Camping area northwest of Phoenix, eight miles west of Lake Pleasant on BLM land. It is suspected that sunlight and/or instability in the mounting caused one or both of the counters to have questionable reliability during the first two months of the test. The counters were remounted from trees onto pipes driven into the ground. Sensitivity was also adjusted to more accurately record multiple vehicles in a group. Staff observed the counts on a high use day to confirm the changes positively affected the counting. Data counts after two months were improved, yet memory limitations caused the counters to fill up at approximately 1,800 counts. In some instances, counters were checked and found to be maxed out. They were reset and the count recorded on the data sheets for the upcoming test. Closer observation of counters in the future and using the date stamp capability could improve the quality of data from the counters.

Opacity Data points for the graph datasets were input from the test data sheets. Opacity observations on all but two test days were conducted by two dust inspectors. The method used to achieve a single opacity data point for graphing was to average the two observations per pass. Diagram 1 below shows how the data was condensed down into a usable form for graphing. On the two tests where only one inspector made observations, there was no need to average the two readings. On these two occasions, Step 1 was simply bypassed and the three opacity observations were averaged as in step 2. Having a single inspector reduced the robustness of judging opacity.

Diagram 1



The number of data points could have been increased, thus adding accuracy to the test. Due to rain and moist soil conditions, three of the ten test days were cancelled. Rain initially was a factor in running the tests, yet when the tests were extended from three months to six months, the true nature of the materials could be observed. Furthermore, the rainfall received in the beginning turned out to be an excellent test of solubility,

presenting possibly the worst case scenario. In the end, both solubility and performance were observed and evaluated.

Opacity vs. Elapsed Time graphs discussion and results: (Graphs A1, A2, A3)

These graphs show the three test vehicles and their associated opacity observations as compared to the test duration measured in days. While there was considerable rain during the test period, the control section was evaluated at the same time the Soiltac and Durasoil sections were evaluated. This gives a baseline for whether or not remaining soil moisture was the main mechanism for dust suppression. Relationships between opacity and duration were sought using the standard graphing software in Microsoft Excel. The data points shown on the Durasoil graph A1 could point to an ever decreasing opacity as time increases, yet that seems unlikely. More data points over time would answer the question of what the slope of the curve should be. A least squares fit line relationship appeared most suitable and is shown in graph A1. Conversely, an exponential relationship was easily shown with the Soiltac test data. Soiltac loses effectiveness quickly at first, and then gradually continues to lose effectiveness as time increases as shown in graph A2. Graph A3 is simply the daily averaged data points from the control section. Since there was significant rainfall during the test, the control section opacity data did not have a trend. While no trend line was assigned, the data serves as a comparison for use against the other test sections as shown on graphs A6-A11.

Lifespan graphs discussion and results: Graphs A4, A5

The extrapolated lifespan graphs A4 and A5 show a projection of a curve or best fit line of the observed opacity percentage data to a point where all three of the vehicle types pass the 20 percent opacity threshold. The county dust standard is 20% opacity or less, so this was used as the extrapolation limit. The Soiltac graph shows short lifespan for Truck (one month) and ATV (2.5months), but a much longer duration for motorcycle (1.5years). Durasoil, however, shows a very long lifespan for the initial application of 1.5years for both trucks and ATVs and 3.5years for motorcycles.

The Soiltac motorcycle extrapolation might make it look like it could be a good application for motorcycle trails. Considering that the difference in opacity between the control and Soiltac sections for the motorcycle is minimal, the cost is not justified. A single pass by a motorcycle will meet or exceed 20% opacity even in the driest conditions according the observations made in this test. The following conditions were not tested, but likely have a negative effect on application lifespan: multiple vehicles in a group, driving with wheels spinning (or intermittent traction), higher speeds. Further testing could identify product limitations or the need for behavioral changes to meet dust standards. It should be recognized that solving the air quality issue will take equal parts of engineering, education and enforcement.

Opacity Differences graphs discussion and results: Graphs A6-A11

The bar graphs showing a particular vehicle types opacity data for Durasoil or Soiltac vs. the control section offers a visual explanation of amount of dust reduction observed. Since opacity as a percentage is difficult to describe, the bar graphs offer a means of showing visually the true difference in the amount of dust generated during the respective test passes. Each graph shows only one vehicle type and compares Durasoil or Soiltac to the untreated control section.

The Soiltac graphs A9-A11 show the dust suppressing ability of this product as used in this application. For this test's sprayed on method of application, the amount of dust reduction is not very high at only 2-7% opacity. On an instance shown on graphs A9 and A10, the Soiltac plot had a higher opacity than the control. This is an immediate failure since the purpose of applying the product is to reduce dust. Furthermore on Graphs A9-A10, the control section had a passing mark of 15% opacity, while Durasoil failed at 20-30%. Perhaps if Soiltac was

mixed in to a recently graded road and compacted, its performance would be higher. This could be tested at other sites in the future.

The Durasoil graphs A6-A8 shows the dust suppressing ability of this product as used in this application. Its non drying properties work very well when sprayed onto the unprepared road surface. Average opacity reductions were 6-15%. The opacity observations were commonly half of the untreated control plot. Furthermore, the application maintained this level of performance for the six month duration of the test.

Cost Analysis:

Cost per mile for applying Durasoil is just over $10,000 per mile at the tested application rate. By the end of the test, over 10,000 vehicle counts were recorded. The extrapolated length of service that might be expected from Durasoil is 1.5 years to 3.5 years, depending upon the type of use. (I.e. mostly truck, ATV or motorcycle). Assuming 20,000 vehicle passes per year based on the observed 10,000+passes over the six month test period and the shorter lifespan of 1.5years from graph A5 for truck traffic, treatment cost per vehicle would be $0.335 per vehicle mile traveled. The lowest cost vehicle to manage dust for is the motorcycle at a per vehicle mile traveled cost of $0.028.

Soiltac initial application cost per mile is lower than Durasoil due to a 7:1 dilution with water, yet the reapplication frequency would need to be much higher, thus raising its per trip cost tenfold. Soiltac cost per vehicle mile is extremely high at $3.29 per vehicle trip mile for a truck, $0.66 for ATV and $0.22 for motorcycle due to poor lifespan and high product cost. This makes it an unattractive solution for dust suppression. Soiltac is best used as a “dust cap” for open areas that need to have the surface stabilized or crusted over for dust compliance.

The bigger question of whether or not controlling dust from vehicles was even possible without daily watering has been answered positively. Dust from vehicles can be managed. Further study is warranted to achieve lower costs. Durasoil should be considered the standard at which other products are tested against.

Cost calculations can be found in Appendix B.

Vehicle Counts Results - Graph A12

Two digital, active infrared vehicle counters were installed. The accumulated counts totaled 11,169 counts over the six month period. Due to counter reliability concerns, a round number of 10,000 counts was used for calculations. The counts were questionable early in the test. Insufficient sensitivity, low mounting rigidity and sensor overloading by afternoon sun blinding were problems believed to have been solved by mounting the counters on steel pipes sticking out of the ground 24inches and re-aiming in a northwesterly direction, away from direct sunlight. A round number of 10,000 counts was used in cost calculations.

Wear Factors and other data:

Durasoil, a soil wetting agent, exhibited excellent durability against water dilution and churning by knobby tires. There was no noticeable loss of effectiveness after receiving over five inches of rain. Rain and knobby tires do appear to be main factors in the early failure of Soiltac. Testing on the Soiltac section was discontinued after only eight weeks. The Soiltac test section actually produced more dust than the control section before being discontinued. Since Durasoil does not evaporate or wash away, its mechanism for dispersal is most likely dilution into the surrounding soil as tires grind it into the soil. The Durasoil remains in the soil where additional applications should have an additive effect.

Physical breakdown of the chemicals due to ultraviolet light is not known. This could be an unknown wear factor that needs consideration, especially for summertime use in Arizona. This warrants mentioning since water and knobby tires are suspected to be the mechanisms that caused Soiltac to fail, yet the failure mechanism is not completely understood. This was not the focus of the study.

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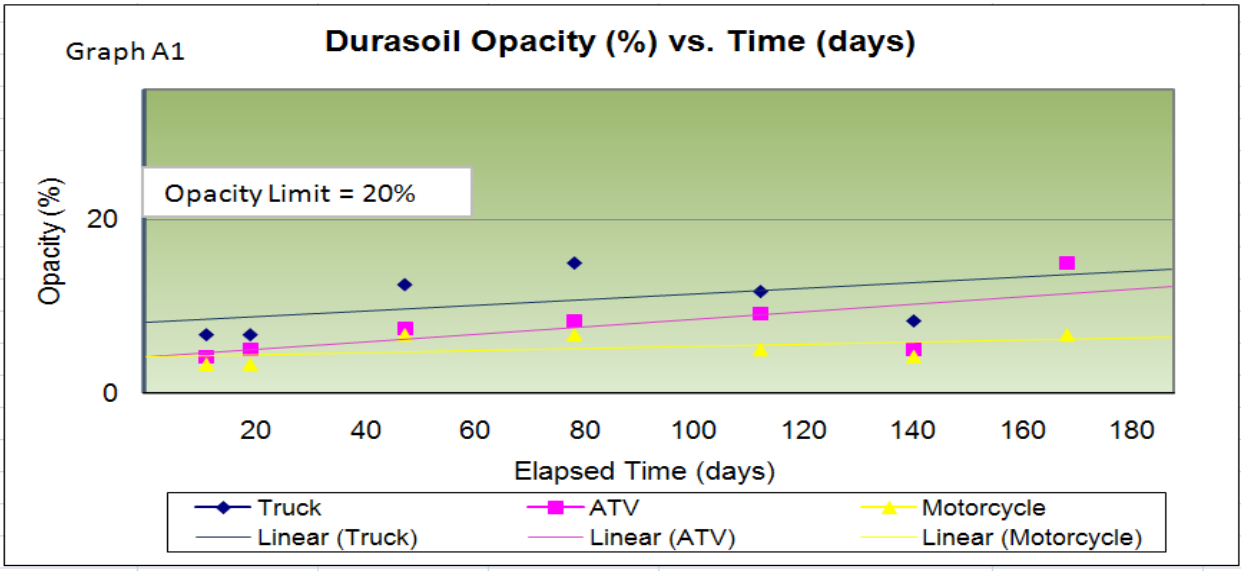
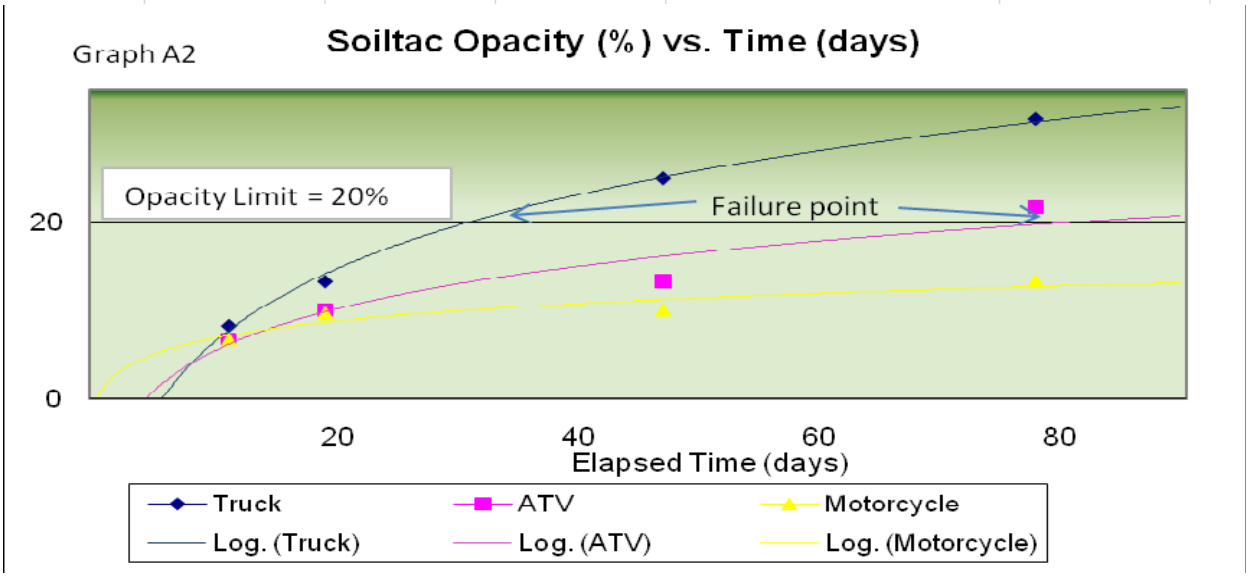
Appendix A Test data analysis

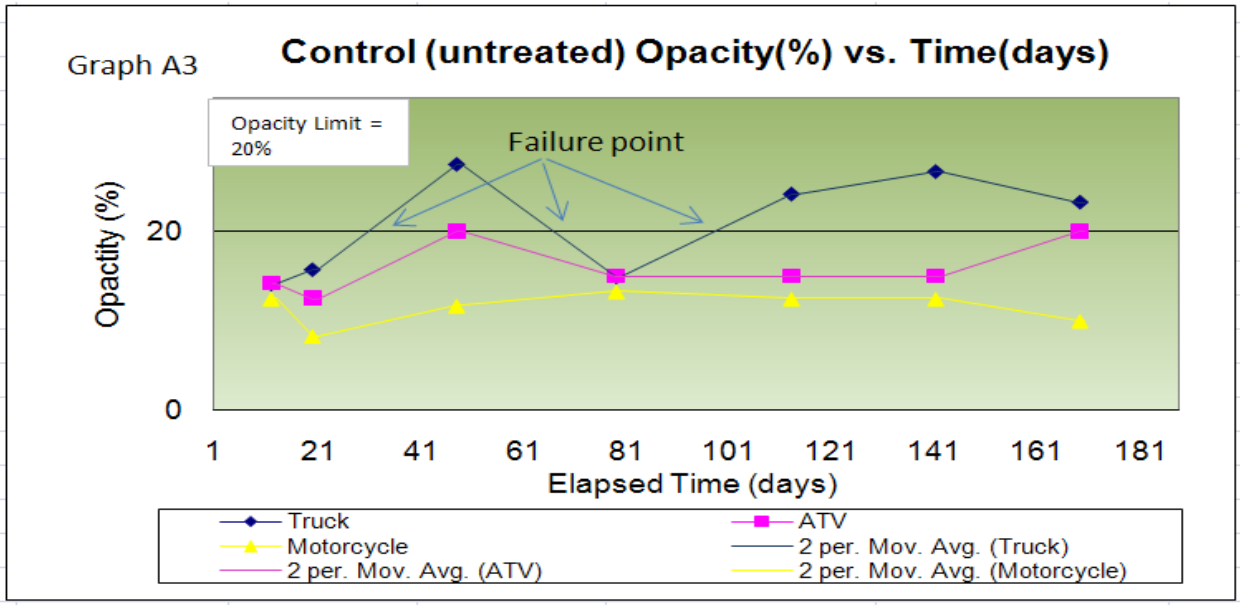
Graph A1

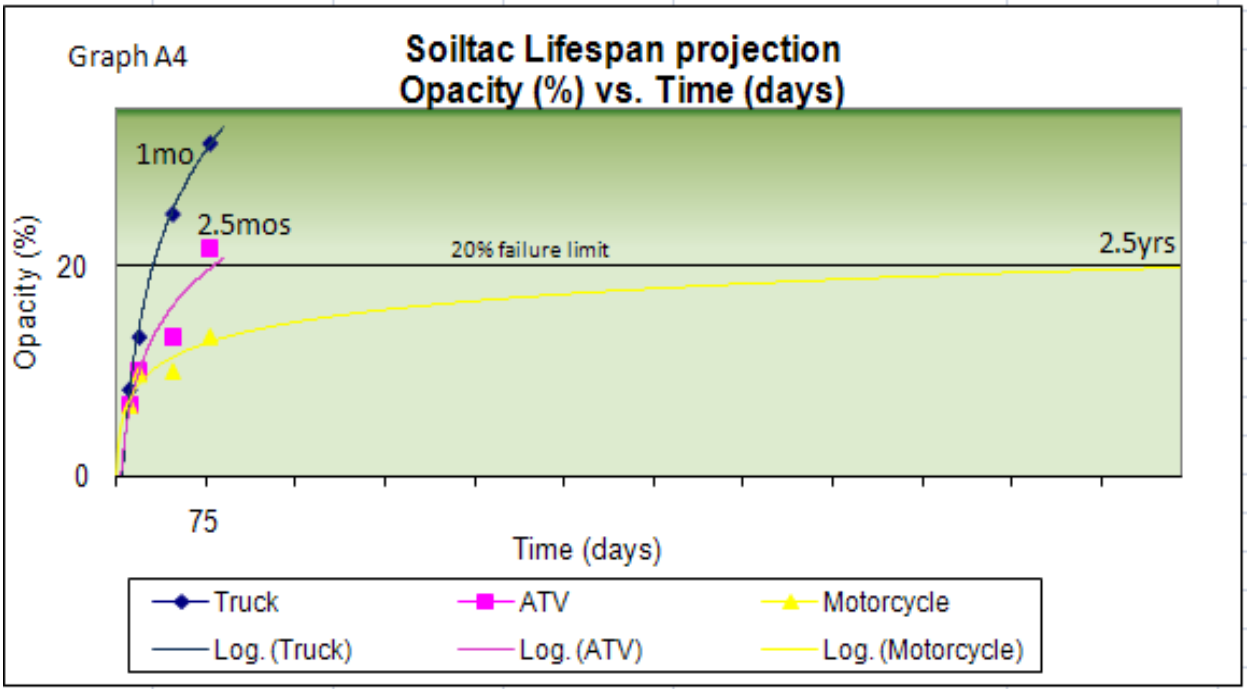


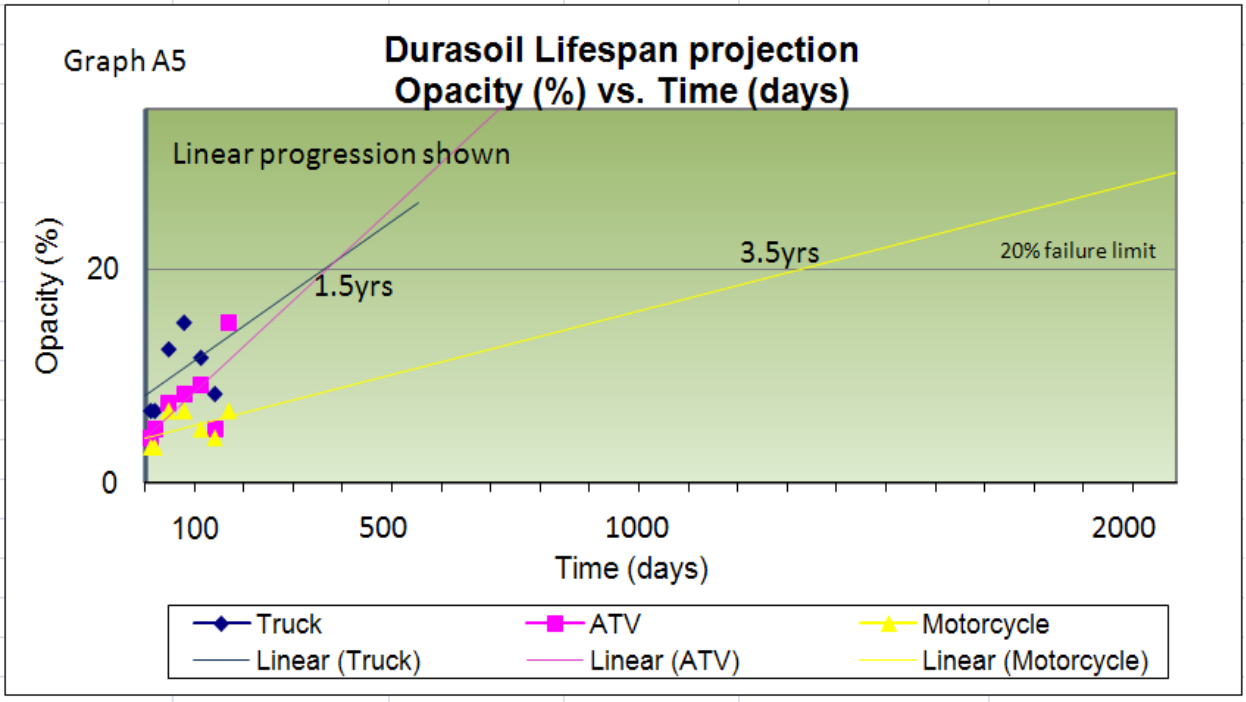
Graph A2



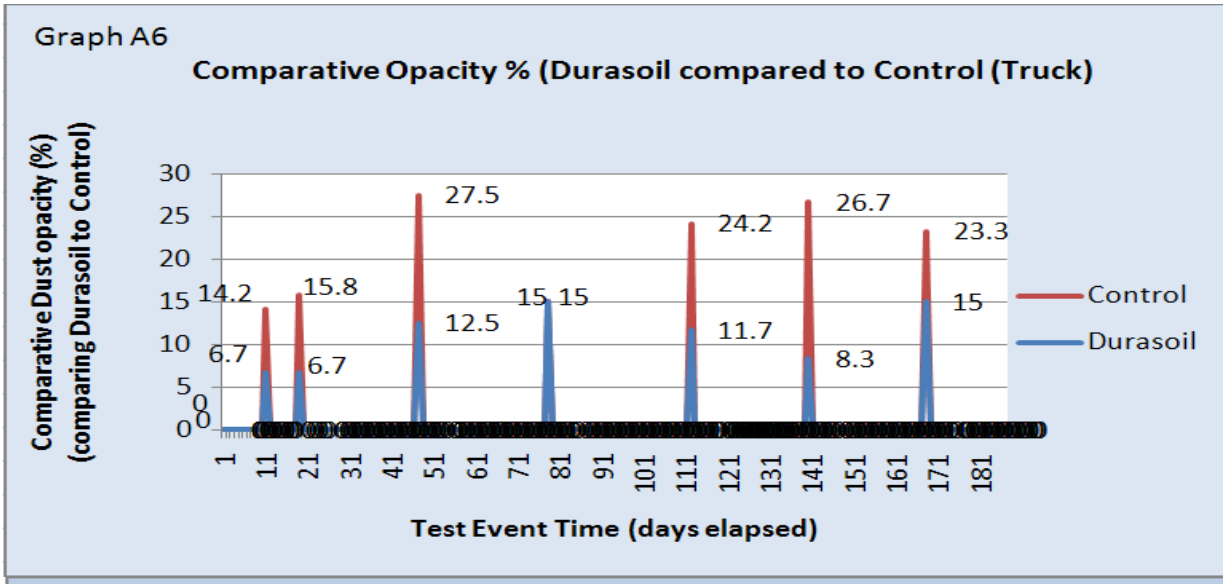
Graph A3



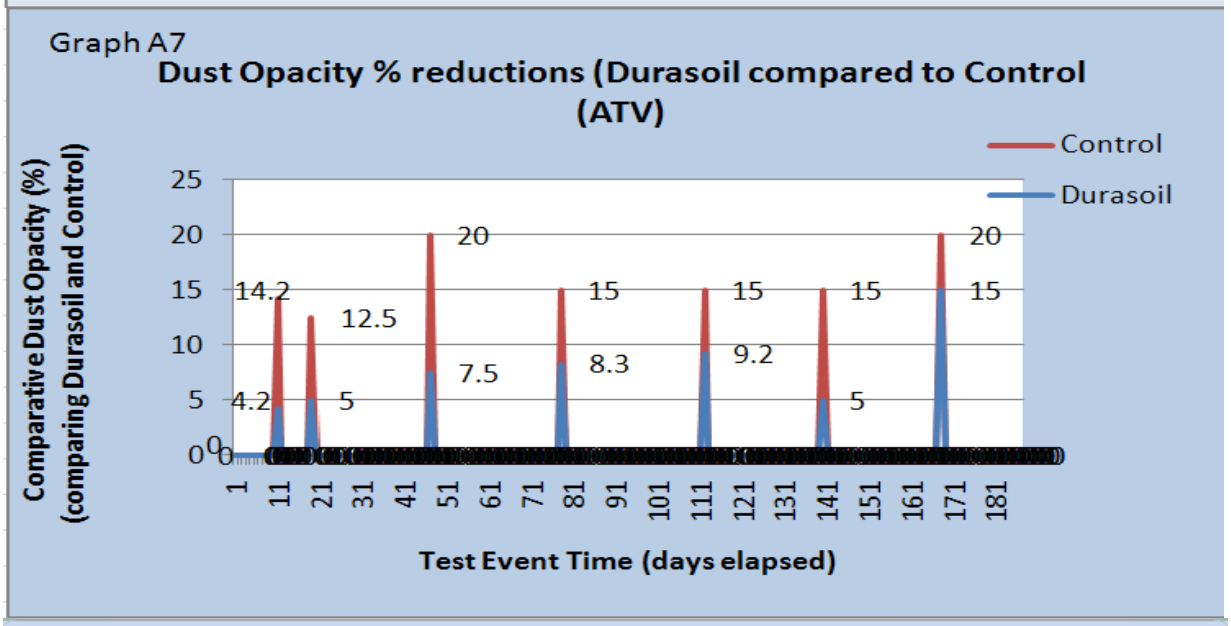

Graph A4
Soiltac Lifespan projection
Opacity (%) vs. Time (days)
1mo
2.5mos
20% failure limit
2.5yrs
Opacity (%)
20
0
75
Time (days)
Truck
ATV
Motorcycle
Log. (Truck)
Log. (ATV)
Log. (Motorcycle)


Graph A5
Durasoil Lifespan projection
Opacity (%) vs. Time (days)
Linear progression shown
3.5yrs
20% failure limit
1.5yrs
Opacity (%)
20
0
100
500
1000
2000
Time (days)
Truck
ATV
Motorcycle
Linear (Truck)
Linear (ATV)
Linear (Motorcycle)

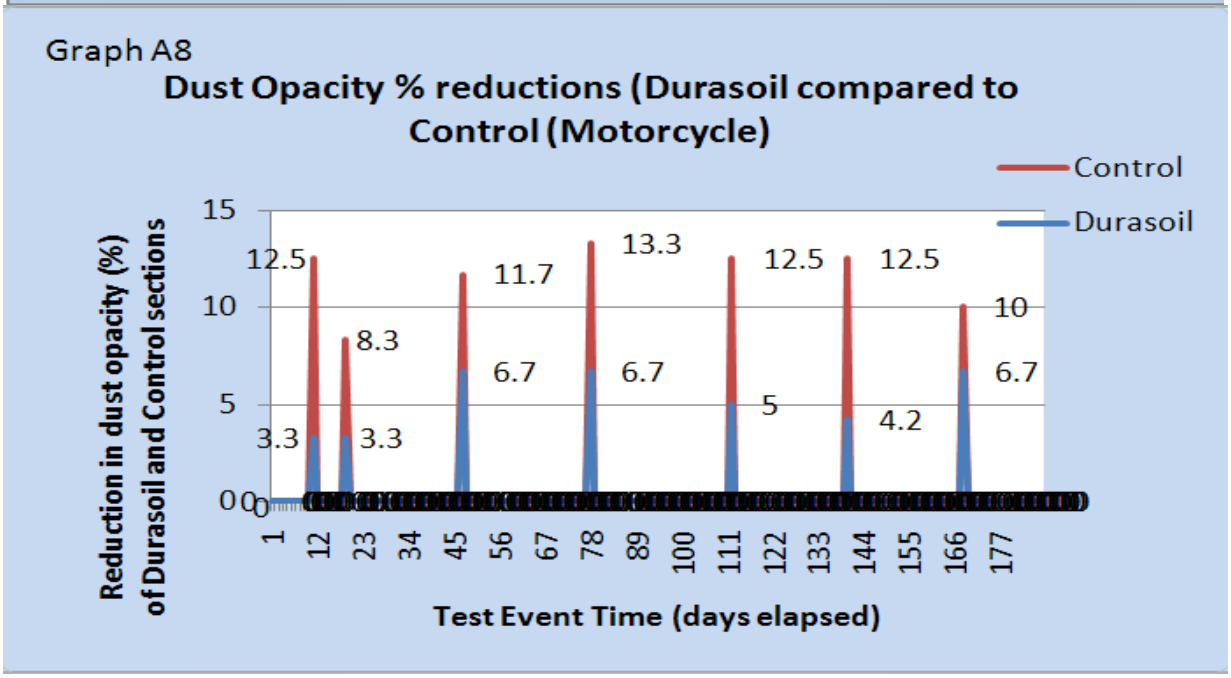
Graph A6



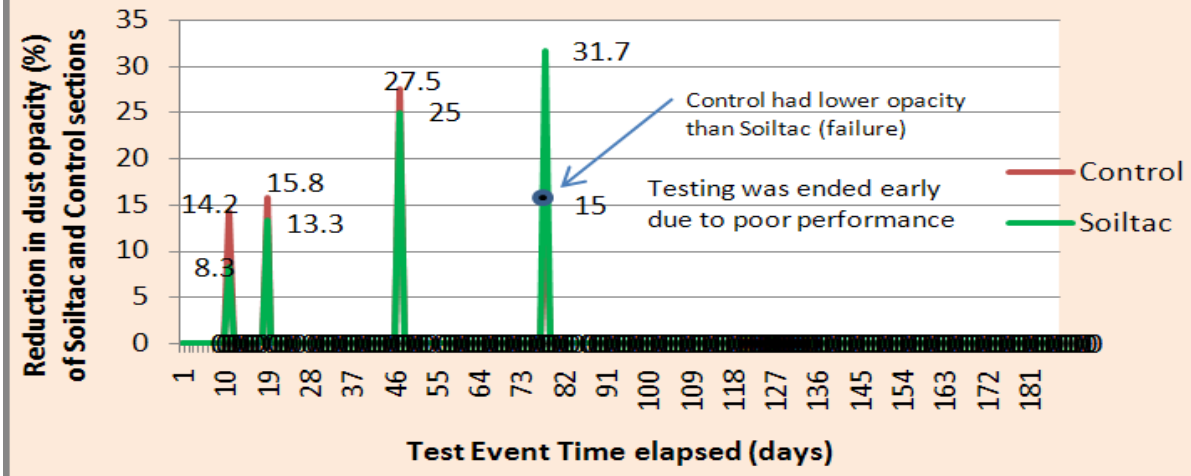
Graph A7



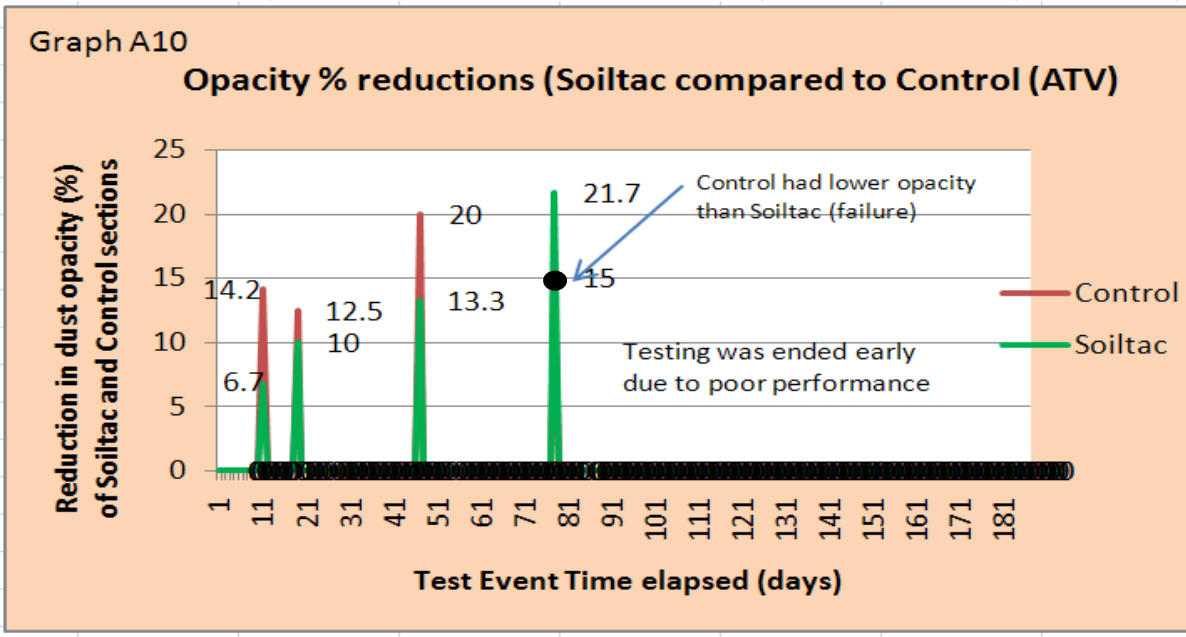
Graph A8



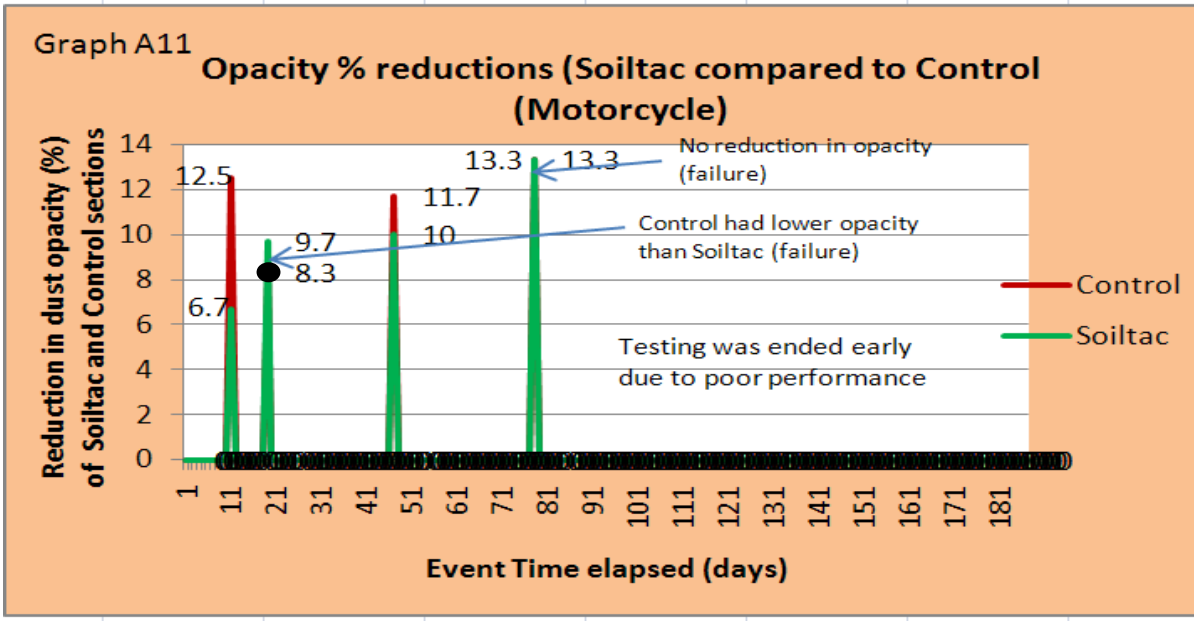
Graph A9

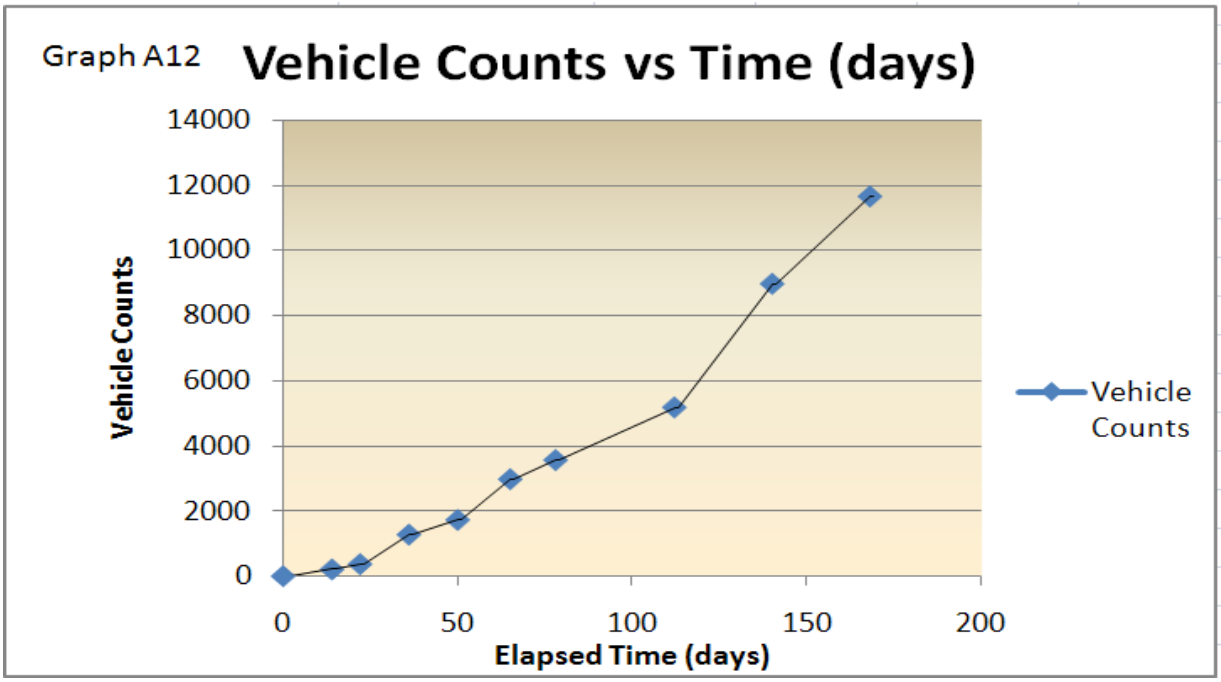


Graph A10



Graph A11




Graph A12
Vehicle Counts vs Time (days)
14000
12000
10000
8000
6000
4000
2000
0
Vehicle Counts
0
50
100
150
200
Elapsed Time (days)
Vehicle Counts

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Appendix B

Cost Calculations

Trip cost calculations

Calcuations

Durasoil		
Application	Light Road per mfr	1 gallon / 30sqft
Test area	450ft long x 10ft wide	4500sqft
Gallons used	4500sqft x 1gal/30sqft	150 gallons
Cost / gallon	$1571.49 / 275gal tote	$5.71 / gallon
Test cost	$5.71/gal x 150 gal	$856.50

Soiltac		
Application	Light Road per mfr	1 gal (diluted 7:1) / 70sqft
Test area	450ft long x 10ft wide	4500sqft
Gallons used	4500sqft x 1gal/70sqft	64.3 gallons
Cost/ gallon	$2000.08 / 275 gal tote	$7.27 / gallon
Test cost	$7.27/gal x 64.3 gal	$467.66

Expected vehicle trip cost per mile over lifespan of application - SOILTAC				
Vehicle trail type		Truck	ATV	Motorcycle
Suppressant cost / sqft	Durasoil = 1gal/70sqft x $7.27/gal	$.1039 / sqft	$0.1039 / sqft	$0.1039 / sqft
Treatment area / mile	Trail width 10ft, 5ft, 2 ft wide x 5280ft/mi	52800 sqft / mile	26400 sqft / mile	10560 sqft / mile
Treatment cost per mile	Treatment area/mile x suppressant cost/sqft	$5485.92 / mi	$2742.96/mi	$1097.18/mi
Yearly trips expected	based on test data of 10,000trips/6mos	20000 trips	20000 trips	20000 trips
Extrapolated lifespan	from graph A5	.0833yrs (1mo)	.208yrs (2.5mos)	2.5years
Total trips over lifespan	Yearly expected trips x Extrapolated lifespan	1666	4160	50000
Expected trip cost per mile over lifespan of application		$3.29/trip/mile	$0.66/trip/mile	$0.022/trip/mile
	Treatment cost/mile / Total trips x extrapolated lifespan)			

Expected vehicle trip cost per mile over lifespan of application - DURASOIL				
Vehicle trail type		Truck	ATV	Motorcycle
Suppressant cost / sqft	Durasoil = 1gal/30sqft x $5.71/gal	$.1903 / sqft	$.1903 / sqft	$.1903 / sqft
Treatment area / mile	10ft, 5ft, 2 ft wide x 5280ft/mile	52800 sqft / mile	26400 sqft / mile	10560 sqft / mile
Treatment cost per mile	Treatment area/mile x suppressant cost/sqft	$10047.84 / mi	$5023.92/mi	$2009.57/mi
Yearly trips expected	based on test data of 10,000trips/6mos	20000 trips	20000 trips	20000 trips
Extrapolated lifespan	from graph A5	1.5yrs	1.5yrs	3.5yrs
Total trips over lifespan	Yearly expected trips x Extrapolated lifespan	30000.0	30000	70000
Expected trip cost per mile over lifespan of application		$0.335/trip/mile	$0.168/trip/mile	$0.028/trip/mile
	Treatment cost per mile / Total trips			

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Appendix C

Dust Suppressant Chemicals

DURASOIL

Product Information

Product Description

Durasoil® is a revolutionary state-of-the-art innovation; engineered for today's challenging dust control needs. This ultra-pure, synthetic organic fluid is formulated to meet the highest standards of environmental efficacy. Durasoil® is distinctively crystal clear, odorless and is applied neat and simple, without the need for water dilution. This technologically advanced fluid does not cure, allowing for immediate use upon its application. Furthermore, Durasoil® has the unique ability to be reworked and still maintain its dust controlling properties. Any equipment capable of spraying water can safely be used to apply Durasoil® without any mess or damage to the equipment. Even in freezing and wet conditions, Durasoil® can still be applied regardless of weather conditions or season. Durasoil® can be applied to any soil or aggregate and effectively suppress dust all year round. From intense-use military tank trails to gravel driveways, Durasoil® is actively solving dust control challenges throughout the world's industrial, military, commercial and residential markets.

Material Safety Data Sheet

Durasoil® Soil Stabilizer & Dust Control Agent Material Safety Data Sheet

SECTION 1 - MATERIAL IDENTIFICATION	
PRODUCT NAME	Durasoil® (Durasoil is a registered trademark of Soilworks, LLC)*
	Durasoil is a registered trademark of Soilworks, LLC.
MANUFACTURER	Soilworks, LLC.
	681 North Monterey Street, Suite 101 Gilbert, Arizona 85233-8318 USA www.soilworks.com
TELEPHONE NUMBER	800-545-5420 Durasoil
ONLINE INFORMATION	www.durasoil.com
EMERGENCY TELEPHONE NUMBERS	800-545-5420 (National & International)
REVISION DATE	March 2006
EMERGENCY OVERVIEW	
PHYSICAL FORM	Bright clear viscous liquid
COLOR	Colorless
ODOR	Odorless
HAZARDS	This material is NOT HAZARDOUS according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200
C.A.S. CHEMICAL NAME	Synthetic Organic Dust Control Agent
SYNONYMS	Dust Palliative, Dust Retardant, Dust Suppressant, Dust Control Material, Dust Inhibitor
CHEMICAL FAMILY	N/A
EMPIRICAL FORMULA	Mixture
INTENDED USE	Control Dust, Retard Dust, Suppress Dust, Inhibit Dust, Stop Dust, Reduce

INTENDED USE	Control Dust, Retard Dust, Suppress Dust, Inhibit Dust, Stop Dust, Reduce Dust, Elimate Dust
REVISION NOTES	None

SECTION 2 - INGREDIENTS

	Chemical Name	%	CAS Number and Chemical Name
1.	Complex mixture of severely hydrotreated, branched alkanes and alkylated saturated ring compounds	Trade Secret	Non-Hazardous
2.	Proprietary Ingredients	Trade Secret	Non-Hazardous

SECTION 3 - HEALTH HAZARDS

ROUTES OF EXPOSURE

Skin, inhalation

Mist 8 hour ACGIH TLV: TWA 5mg/m3

This product may cause irritation to the eyes, nose, throat, lungs and skin after prolonged or repeated exposure.

CARCINOGENS UNDER OSHA, ACGIH, NTP, IARC

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA, or ACGIH as a carcinogen..

SECTION 4 - FIRST AID

EYE CONTACT

Flush eyes with flowing water and continue flushing until irritation subsides. If irritation persists, seek medical attention.

SKIN CONTACT

Remove contaminated clothing and shoes. Wash affected area with soap and water. If redness or irritation occurs, seek medical attention.

INHALATION

This material has a low vapor pressure and is not expected to present an inhalation exposure at ambient conditions. If vapor or mist is generated when the material is heated or handled, move subject to fresh air. If is unconscious, remove to fresh air and seek immediate medical attention.

INGESTION

Do not induce vomiting due to aspiration hazard. Seek immediate medical attentionn.

SECTION 5 - FIRE AND EXPLOSION DATA

FLASH POINT (closed cup)	>300 F (>149 C)
TEST METHOD	ASTM D-93 (PMCC)
FLAMMABLE LIMITS IN AIR	No Data Available
AUTOIGNITION TEMPERATURE	No Data Available
EXTINGUISHING MEDIA	Use dry chemical, foam, or carbon dioxide.
SPECIAL FIRE FIGHTING PROCEDURES	Water may be ineffective but can be used to cool containers exposed to heat or flame.

UNUSUAL FIRE AND EXPLOSION HAZARDS

Dense smoke may be generated while burning. Carbon monoxide, carbon dioxide, and other oxides may be generated as products of combustion.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

CONTAINMENT TECHNIQUES

Remove all sources of ignition. Stop the leak, if possible.

CLEAN-UP PROCEDURES

Wear suitable protective equipment. Contain spill immediately. Do not allow spill to enter sewers or open bodies of water. Absorb with inert absorbent materials. Large spills may be picked up using vacuum pumps, shovels, buckets, or other means and place in drums or other suitable containers..

SECTION 7 - HANDLING AND STORAGE

STORAGE

Do not transfer to unmarked containers. Store in a cool, well ventilated area in closed containers away from heat, sparks, open flame or oxidizing materials.

HANDLING

Avoid breathing vapors or mist. Avoid contact with eyes. Avoid prolonged or repeated contact with skin. Wash thoroughly after handling. Wash clothing prior to reuse. May be slippery when spilled.

SECTION 8 - PERSONAL PROTECTION / EXPOSURE CONTROLS

EXPOSURE LIMITS AND GUIDELINES

This product does not contain any components with OSHA or ACGIH exposure limits. If mist is generated, exposure limits apply.
OSHA PEL: TWA 5 mg/m3
ACGIH TLV: TWA 5 mg/m3

EYE PROTECTION

Eye protection is not required under conditions of normal use. If material is handled such that it could be splashed into eyes, wear splash-proof safety goggles.

SKIN PROTECTION

No skin protection is required for single, short duration exposures. For prolonged or repeated exposures, use impervious synthetic rubber (boots, gloves, aprons, etc.) over parts of the body subject to exposure (Nitrile recommended). Launder soiled cloths.

RESPIRATORY PROTECTION

Not required under normal conditions in a well-ventilated workspace. An organic vapor respirator National Institute for Occupational Safety and Health (NIOSH) approved for organic vapors is recommended under emergency conditions.

ENGINEERING CONTROLS

If vapor or mist is generated when the material is heated or handled, adequate ventilation in accordance with good engineering practice must be provided to maintain concentrations below the specified exposure or flammable limits..

WORK AND HYGIENIC PRACTICES

Always wash hands and face with soap and water before eating, drinking, or smoking.

SECTION 9 - TYPICAL PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM	Bright clear viscous liquid
COLOR	None, Colorless
ODOR	None, Odorless
pH	N/A, Not an aqueous solution
VAPOR PRESSURE	<1 (mm Hg)
VAPOR DENSITY (Air = 1)	<1
BOILING POINT	>500 F (>260 C)
MELTING POINT	No Data Available
SOLUBILITY IN WATER	Insoluble in water
SPECIFIC GRAVITY (Water = 1)	0.845-0.865
POUR POINT	-5 F (-15 C)

SECTION 10 - STABILITY AND REACTIVITY

CHEMICAL STABILITY

Stable.

CONDITIONS TO AVOID

Heat, sparks, flame.

INCOMPATIBILITY (Materials to Avoid)

May react with strong oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide, and other oxides may be generated as products of combustion.

HAZARDOUS POLYMERIZATION

Will not occur

SECTION 11 - TOXICOLOGICAL PROPERTIES

ACUTE ORAL TOXICITY (LD50, Rat)

No data.

ACUTE DERMAL TOXICITY (LD50 Rabbit)

No data.

ACUTE INHALATION TOXICITY (LC50, Rat)

No data.

IRRITATION EFFECTS DATA

No data.

CHRONIC/SUBCHRONIC DATA

No data.

SECTION 12 - ECOLOGICAL INFORMATION

No data
Available.

SECTION 13 - DISPOSAL CONSIDERATIONS

REGULATORY INFORMATION

All disposals must comply with federal, state and local regulations. This material, if spilled or discarded, may be a regulated waste. Refer to state and local regulations. Department of Transportation (DOT) regulations may apply for transporting this material when spilled.

WASTE DISPOSAL METHODS

Waste materials may be landfilled or incinerated at an approved facility. Materials should be recycled if possible.

SECTION 14 - TRANSPORT INFORMATION

DOT NON-BULK SHIPPING NAME	Not regulated
DOT BULK SHIPPING NAME	Not regulated
IMO SHIPPING DATA	Not regulated
ICAO/IATA SHIPPING DATA	Not regulated

SECTION 15 - REGULATORY INFORMATION

TOXIC SUBSTANCES CONTROL ACT (TSCA) 12(b) COMPONENT(S)

None.

OSHA HAZARD COMMUNICATION STANDARD (29CFR1310.1200) HAZARD CLASS(ES)

None.

EPA SARA TITLE III SECTION 312 (40CFR370) HAZARD CLASS

None.

EPA SARA TITLE III SECTION 313 (40CFR372)TOXIC CHEMICALS ABOVE "DE MINIMUS " LEVEL ARE

None.

CANADIAN REGULATIONS

This product is not a controlled product under the Canadian Workplace Hazardous Material Information System (WHMIS).

SECTION 16 –INTERNATIONAL REGULATIONS

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process

SOILTAC

Product Information

Product Description

Soiltac® is a polymer-based emulsion used primarily to stabilize all soils from dust and erosion. It is specifically engineered for ease of use for large commercial projects down to smaller residential applications. It can be as simple to apply as watering the ground. Furthermore, Soiltac® is designed to work its way down into the soil to maximize the penetration depth. The result is a thicker protective barrier with a more rigid and stable base. Once cured, Soiltac® becomes completely transparent, leaving the natural landscape to appear untouched. Soiltac® results are based on the application rate used. Modest applications can create a light temporary surface crust that is permeable by water and is useful for dust control needs. On the other hand, heavy applications can generate results similar to the qualities of cement. Most importantly, Soiltac® is a truly biodegradable product that is completely environmentally safe to use.

Material Safety Data Sheet

Soiltac® Soil Stabilizer & Dust Control Agent Material Safety Data Sheet

SECTION 1 - MATERIAL IDENTIFICATION	
PRODUCT NAME	SOILTAC*
	SOILTAC is a registered trademark of Soilworks, LLC.
MANUFACTURER	Soilworks, LLC.
	681 North Monterey Street, Suite 101 Gilbert, Arizona 85233-8318 USA www.soilworks.com
TELEPHONE NUMBER	800-545-5420
ONLINE INFORMATION	www.Soiltac.com
EMERGENCY TELEPHONE NUMBERS	800-545-5420 (National & International)
REVISION DATE	November 2006 *(supersedes March 2006)*
EMERGENCY OVERVIEW	
PHYSICAL FORM	Mobile liquid
COLOR	Milky White (transparent once cured)
ODOR	Mild / Slight (no odor once cured)
HAZARDS	There are no known health hazards.
EXTINGUISHING MEDIA	The product will only burn after the water it contains is driven off.
C.A.S. CHEMICAL NAME	Mixture
SYNONYMS	Soil stabilizer, soil stabilization agent, soil solidifier, soil amendment, soil additive, soil crusting agent, dust control agent, dust inhibitor, dust palliative, dust suppressant, dust retardant
CHEMICAL FAMILY	Vinyl Copolymer Emulsion
EMPIRICAL FORMULA	Mixture

INTENDED USE	Soil stabilization, soil solidification, fugitive dust control, dust suppression, dust abatement, tackifier, dust abatement, PM10 and PM2.5 air quality control and erosion control

SECTION 2 - INGREDIENTS

	%	CAS Number	Chemical Name
1.	50-60	Proprietary	Vinyl Copolymer
2.	40-60	7732-18-5	Water

SECTION 3 - HEALTH HAZARDS

ROUTES OF ENTRY

Eye Contact, Skin Contact, Ingestion and Inhalation

SIGNS AND SYMPTOMS OF ACUTE EXPOSURE

Eyes: Direct contact with this material may cause eye irritation including lachrymation (tearing).
Inhalation: Inhalation of vapor or aerosol may cause irritation to the respiratory tract (nose, throat, and lungs).
Skin: Contact may cause skin irritation. Ingestion: No hazard in normal industrial use. Skin: Contact may cause skin irritation. Ingestion: No hazard in normal industrial use.

SIGNS AND SYMPTOMS OF CHRONIC EXPOSURE

Prolonged or repeated contact with skin may cause irritation and dermatitis (inflammation).

CARCINOGENICITY

This material **does not** contain 0.1% or more of any chemical listed by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), or regulated by the Occupational Safety and Health Administration (OSHA) as a carcinogen.

SECTION 4 - FIRST AID

EYE CONTACT

Rinse immediately with plenty of water. Get immediate medical attention.

SKIN CONTACT

Remove contaminated clothing and shoes. Wash affected area with soap and water. Get medical attention if irritation develops or persists.

INHALATION

Move patient to fresh air. If breathing has stopped or is labored give assisted respiration (e.g. mouth-to-mouth). Supplemental oxygen may be indicated. Seek medical advice.

INGESTION

Give the victim one or two glasses of water or milk to drink. Get immediate medical attention . Never give anything by mouth to an unconscious person.

SECTION 5 - FIRE AND EXPLOSION DATA

FLASH POINT (closed cup)	Not applicable
UPPER EXPLOSION LIMIT (UEL)	Not applicable
LOWER EXPLOSION LIMIT (LEL)	Not applicable
AUTOIGNITION TEMPERATURE	Not applicable
FIRE HAZARD CLASSIFICATION (OSHA/NFPA)	Non-Combustible

EXTINGUISHING MEDIA

Product does not burn. The product will only burn after the water it contains is driven off. For dry polymer use carbon dioxide, foam, dry chemical or water fog to extinguish fire. Aqueous solution **is not flammable**.

FIRE FIGHTING EQUIPMENT

Wear self-contained breathing apparatus (SCBA) and full fire-fighting protective clothing. Thoroughly decontaminate all protective equipment after use.

FIRE AND EXPLOSION HAZARDS

This material **will not burn** unless it is evaporated to dryness. Closed containers may rupture when exposed to extreme heat.

HAZARDOUS COMBUSTION PRODUCTS

When dried polymer burns, water (H2O), carbon dioxide (CO2), carbon monoxide (CO) and smoke are produced.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

CONTAINMENT TECHNIQUES (Removal of ignition sources, diking etc)

Stop the leak, if possible. Ventilate the space involved.

CLEAN-UP PROCEDURES

Wear suitable protective equipment. If recovery is not feasible, admix with dry soil, sand or non-reactive absorbent and place in an appropriate chemical waste container. Prevent spilled material from entering sanitary sewers, storm sewers, drainage systems and from entering bodies of water or ditches that lead to waterways. Transfer to containers by suction, preparatory for later disposal. Place in metal containers for recovery or disposal. Flush area with water spray. Wash contaminated property (e.g., automobiles) quickly before the material dries. For large spills, recover spilled material with a vacuum truck.

OTHER EMERGENCY ADVICE

Spilled polymer emulsion is very slippery. Use care to avoid falls. A film will form on drying. Remove saturated clothing and wash contacted skin area with soap and water. Product imparts a milky white color to contaminated waters. Foaming may result. Sewage treatment plants may not be able to remove the white color imparted to the water.

SECTION 7 - HANDLING AND STORAGE

STORAGE

Keep from freezing. Store in a dry area. Keep containers closed when not in use to minimize contact with atmospheric air and prevent inoculation with microorganisms.

HANDLING

Use only in well-ventilated areas. Avoid contact with eyes. Avoid breathing vapors. Avoid prolonged or repeated contact with skin. Wash hands thoroughly after handling and before eating or drinking.

SECTION 8 - PERSONAL PROTECTION / EXPOSURE CONTROLS

EXPOSURE GUIDELINES

There are no Occupational Safety and Health (OSHA) Permissible Exposure Limits (PEL) or American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) or Short Term Exposure Limits (STEL) established for the component(s) of this product.

EYE PROTECTION

Chemical safety glasses.

HAND PROTECTION

Rubber Gloves. The breakthrough time of the selected glove(s) must be greater than the intended use period.

RESPIRATORY PROTECTION

No specific recommendation.

ENGINEERING CONTROLS

Good general ventilation should be sufficient to control airborne levels of irritating vapors.

SECTION 9 - TYPICAL PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM	liquid
COLOR	Milky White (transparent once cured)
ODOR	Mild / Slight (no odor once cured)
pH	4. 5-6.0
EVAPORATION RATE	< 1 (BuAc=1)
VAPOR DENSITY	> 1 (Air = 1)
BOILING POINT	> 100.00°C (>212.00°F)
FREEZING POINT	<0°C (<32°F)
SOLUBILITY IN WATER	Completely (100%) (until cured)
SPECIFIC GRAVITY (Water = 1)	1.0 5-1.10

SECTION 10 - STABILITY AND REACTIVITY

STABILITY

Stable at ambient temperatures. Coagulation may occur following freezing, thawing or boiling.

INCOMPATIBILITY (Materials to Avoid)

No incompatibilities have been identified.

HAZARDOUS DECOMPOSITION PRODUCTS

Thermal decomposition may form: Acetic acid and Acrolein. Thermal decomposition may produce various hydrocarbons and irritating, acrid vapors.

HAZARDOUS POLYMERIZATION

Will not occur

CONDITIONS TO AVOID

Freezing temperatures (until cured).

SECTION 11 - TOXICOLOGICAL PROPERTIES

ACUTE EYE TOXICITY

No Information is available.

ACUTE ORAL TOXICITY

No Information is available.

ACUTE SKIN TOXICITY

No Information is available.

ACUTE INHALATION TOXICITY

No Information is available.

CHRONIC/CARCINOGENICY

This material **does not** contain 0.1% or more of any chemical listed by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), or regulated by the Occupational Safety and Health Administration (OSHA) as a carcinogen.

SECTION 12 - ECOLOGICAL INFORMATION

ECOTOXICITY

Common Name	Species	Test	Result	Concentration
Green Algae	Raphidocelus Subcapitata	96-hr chronic LC50	>1,000	Undiluted
Fathead Minnow	Pimephales Promelas	96-hr acute LC50	>1,208	Undiluted
Rainbow Trout	Oncorhynchus Mykiss	96-hr acute LC50	>1,000	Undiluted

ENVIRONMENTAL FATE

No data is available.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD

This material **is not** a RCRA hazardous waste. Disposal of this material is not regulated under RCRA. Consult federal, state and local regulations to ensure that this material and its containers, if discarded, is disposed of in compliance with all regulatory requirements . NOTE: As supplied or diluted, product material (foam included), when splashed on automobiles or other personal property, is difficult to remove if allowed to dry.

RCRA HAZARD CLASS

This material **is not** a RCRA hazardous waste. When discarded in its purchased form, this material would not

be regulated as a RCRA Hazardous waste under 40 CFR 261.

SECTION 14 - TRANSPORT INFORMATION	
DOT NON-BULK SHIPPING NAME	Refer to Bill of Lading - Not DOT Regulated // Keep From Freezing // Not dangerous goods
DOT BULK SHIPPING NAME	Refer to Bill of Lading.
IMO SHIPPING DATA	Refer to Bill of Lading.
ICAO/IATA SHIPPING DATA	Refer to Bill of Lading - Not IATA Regulated // Keep From Freezing // Not dangerous goods
CFR	Not Regulated // Keep From Freezing // Not dangerous goods
IMDG	Not Regulated // Keep From Freezing // Not dangerous goods
CTC	Not Regulated // Keep From Freezing // Not dangerous goods

SECTION 15 - REGULATORY INFORMATION

TSCA SECTION 8(b) INVENTORY STATUS
All components are included in the EPA Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

TSCA SECTION 12(b) EXPORT NOTIFICATION
This material **does not** contain any components that are subject to the U.S. Toxic Substances Control Act (TSCA) Section 12 (b) Export Notification requirements.

OSHA Hazard Communication Standard (29CFR1910.1200) hazard class(es)
This material **is not** classified as hazardous under the criteria of the U.S. Occupational Safety and Health Administration (OSHA) Hazard Communication Standard, 29 CFR 1910.1200

EPA SARA Title III Section 304 CERCLA
Reportable quantities have not been established for any of this material's components.

EPA SARA Title III Section 311/312 HAZARD COMMUNICATION STANDARD (HCS)
This material **is not** a hazardous chemical.

EPA SARA Title III Section 313 TOXIC CHEMICAL LIST (TCL)
This product **does not** contain Section 313 Reportable Ingredients.

CANADIAN INVENTORY STATUS
All components of this material are listed on the Canadian Domestic Substances List (DSL)

CANADIAN WHMIS
This material **is not** classified as a controlled product under the Canadian Workplace Hazardous Material Information System.

ADDITIONAL CANADIAN REGULATORY INFORMATION
This product **does not** contain a substance present on the WHMIS Ingredient Disclosure List (IDL) which is at or above the specified concentration limit.

EUROPEAN INVENTORY STATUS (EINECS)
The polymer portion of this product is manufactured from reactants which are listed on EINECS and meets the EINECS definition of an exempt polymer.

AICS (Australia)
Included on inventory

ENCS (Japan)
Included on inventory

ECL (South Korea)
Included on inventory

SEPA (China)
Included on inventory

SECTION 16 – OTHER INFORMATION

HMIS and NFPA Classification

Health	: 1
Flammability	: 0
Reactivity	: 0
Special Hazard	: 0

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Appendix D

Test Vehicles

Truck – 2004 Ford F-250 4x4
Engine size: 5.4L Unleaded gas
Curb weight: 5,648lbs
Tire size/brand: F Goodyear Wrangler LT265/75R16
R Goodyear Wrangler LT265/75R16
Inflation: 75psi F/R

ATV – 2007 Polaris Sportsman 500
Engine size: 500cc Unleaded gas
Curb weight: 773lbs (deluxe model)
Tire size/brand: R 26x11R12
F 26x8R12
Inflation: 5psi F/R

Motorcycle – 2001 Suzuki DRZ 250
Engine size: 250cc Unleaded gas
Curb weight: 253lbs
Tire size/brand: R- 100/110 – 18 Dunlop D756
F – 90/90 – 21 Michelin S-12
Inflation: 15lbs F/R

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Appendix E

Traffic Counters – 2 used

TRAILMASTER®
Infrared Trail Monitors

TM1050™ *Active Infrared* Trail Monitor

Cannot be used with TRAILMASTER accessories

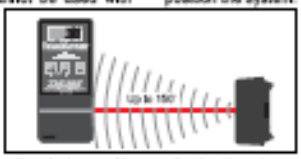
Includes:
Infrared Transmitter
Infrared Receiver
Nylon mounting straps
Event Data Pad

- Uses invisible active infrared light beam
- Can be easily set for specific game
- Can store over 1000 events
- Non-Volatile memory
- Records date of event and time to the minute
- Operates 8 to 12 months on C-cell batteries
- Can be used up to a distance of 150 feet
- Compact and easy to set up
- Weather-proof (temp. range: -40°F to +130°F)

TRAILMASTER's *active infrared* systems, the TM1550 and the TM1050, are two-piece monitors which set up an invisible beam across the trail between the transmitter and the receiver. The two monitors are identical, with one exception. The TM1050 cannot be used with accessories. The TM1550 is the monitor you need if you want to add any accessory, such as the TM35-1 Camera Kit.

By setting the beam at the chest height of the animal you want to monitor, and controlling the length of time the beam must be blocked before it registers as an event, you can count only the animals you want and ignore other animals or objects which pass through the beam. This patented system provides a monitor which is easy to align, but one with selective sensitivity to allow you to monitor an area for movement of *specific game*. This is the technology the competition tries to imitate.

Each time an animal passes through the infrared beam, the event is recorded by date and time to the minute. TRAILMASTER lets you record and store 1000 events. With the TM1050 you can collect event information which will show patterns of game movement and prevent drawing incorrect conclusions based on a small number of events.



The TM1050 trail monitor has many features which make it ideal for field use. An alignment light is built in, making it easy for one person to position the system. The large, wide temperature range digital display is easily read even at cold temperatures, and the simple data retrieval method lets you review the time and date of each event as many times as needed. Defaults are programmed in so that the unit will automatically begin collecting data even if the operator forgets to set the proper mode. The TM1050 has a manual readout procedure that makes the event data easy to retrieve.

TRAILMASTER monitors are weather-proof, allowing them to remain in the field collecting data during any weather conditions, including rain and snow. Nylon straps make the monitors easy to mount securely to a tree or post. With their many features, the TRAILMASTER monitors offer dependability and are still simple to use. TRAILMASTER's active infrared system has 150' of range so it can be easily concealed well off the trail.

Call our toll free number or visit our website for more information.

In a recent test conducted by the U.S. Forest Service to evaluate the accuracy of trail monitors, two-piece, active infrared trail monitors were found to be the only monitors which provide consistently accurate information.

"When you want 'THE ONE THAT WORKS,'
. . . get the Original TRAILMASTER."

See our complete product line at
www.trailmaster.com

FOR A FREE CATALOG or
ORDER 1-800-544-5415

TRAILMASTER Infrared Trail Monitors • 10614 Widmer • Lenexa, KS 66215 • TEL 913-345-8555 • FAX 913-345-8272 •
sales@trailmaster.com

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Appendix F

Rainfall Data
http://www.fcd.maricopa.gov/Rainfall/ALERT/ssdata.aspx

ALERT System – Single-Sensor Data Report Generat

Single - Sensor Report

Station Name: Chrysler P. Ground

FCD of Maricopa County ALERT System
Date Time
05/23/2008-09:55:19

DeviceID	5460
StatType	last
DataType	precip
Units	in
1day at 24:00:00	
05/21/08	5.31
05/20/08	5.31
05/19/08	5.31
05/18/08	5.31
05/17/08	5.31
05/16/08	5.31
05/15/08	5.31
05/14/08	5.31
05/13/08	5.31
05/12/08	5.31
05/11/08	5.31
05/10/08	5.31
05/09/08	5.31
05/08/08	5.31
05/07/08	5.31
05/06/08	5.31
05/05/08	5.31
05/04/08	5.31
05/03/08	5.31
05/02/08	5.31
05/01/08	5.31
04/30/08	5.31
04/29/08	5.31
04/28/08	5.31
04/27/08	5.31
04/26/08	5.31
04/25/08	5.31
04/24/08	5.31
04/23/08	5.31
04/22/08	5.31
04/21/08	5.31
04/20/08	5.31
04/19/08	5.31
04/18/08	5.31
04/17/08	5.31
04/16/08	5.31
04/15/08	5.31
04/14/08	5.31
04/13/08	5.31
04/12/08	5.31
04/11/08	5.31
04/10/08	5.31
04/09/08	5.31

04/08/08	5.31
04/07/08	5.31
04/06/08	5.31
04/05/08	5.31
04/04/08	5.31
04/03/08	5.31
04/02/08	5.31
04/01/08	5.31
03/31/08	5.31
03/30/08	5.31
03/29/08	5.31
03/28/08	5.31
03/27/08	5.31
03/26/08	5.31
03/25/08	5.31
03/24/08	5.31
03/23/08	5.31
03/22/08	5.31
03/21/08	5.31
03/20/08	5.31
03/19/08	5.31
03/18/08	5.31
03/17/08	5.31
03/16/08	5.31
03/15/08	5.31
03/14/08	5.31
03/13/08	5.31
03/12/08	5.31
03/11/08	5.31
03/10/08	5.31
03/09/08	5.31
03/08/08	5.31
03/07/08	5.31
03/06/08	5.31
03/05/08	5.31
03/04/08	5.31
03/03/08	5.31
03/02/08	5.31
03/01/08	5.31
02/29/08	5.31
02/28/08	5.31
02/27/08	5.31
02/26/08	5.31
02/25/08	5.31
02/24/08	5.31
02/23/08	5.31
02/22/08	5.31
02/21/08	5.24
02/20/08	5.24
02/19/08	5.24
02/18/08	5.24
02/17/08	5.24
02/16/08	5.24
02/15/08	5.24
02/14/08	5.24
02/13/08	5.24
02/12/08	5.24
02/11/08	5.24
02/10/08	5.24
02/09/08	5.24

02/08/08	5.24
02/07/08	5.24
02/06/08	5.24
02/05/08	5.24
02/04/08	5.24
02/03/08	5.00
02/02/08	5.00
02/01/08	5.00
01/31/08	5.00
01/30/08	5.00
01/29/08	5.00
01/28/08	5.00
01/27/08	5.00
01/26/08	3.46
01/25/08	3.46
01/24/08	3.46
01/23/08	2.99
01/22/08	2.99
01/21/08	2.99
01/20/08	2.99
01/19/08	2.99
01/18/08	2.99
01/17/08	2.99
01/16/08	2.99
01/15/08	2.99
01/14/08	2.99
01/13/08	2.99
01/12/08	2.99
01/11/08	2.99
01/10/08	2.99
01/09/08	2.99
01/08/08	2.99
01/07/08	2.99
01/06/08	2.72
01/05/08	2.72
01/04/08	2.72
01/03/08	2.72
01/02/08	2.72
01/01/08	2.72
12/31/07	2.72
12/30/07	2.72
12/29/07	2.72
12/28/07	2.72
12/27/07	2.72
12/26/07	2.72
12/25/07	2.72
12/24/07	
12/23/07	
12/22/07	2.72
12/21/07	2.72
12/20/07	2.72
12/19/07	2.72
12/18/07	2.72
12/17/07	2.72
12/16/07	2.72
12/15/07	2.72
12/14/07	2.72
12/13/07	2.72
12/12/07	2.72
12/11/07	2.72
12/10/07	2.72
12/09/07	2.72
12/08/07	2.72
12/07/07	2.72
12/06/07	1.97
12/05/07	1.97
12/04/07	1.97
12/03/07	1.97
12/02/07	1.97
12/01/07	1.97
11/30/07	1.54
11/29/07	0.00
11/28/07	0.00
11/27/07	0.00
11/26/07	0.00

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Appendix G

Photos

Watering between test sections

Durasoil test section with truck

Rider on motorcycle on Durasoil section

Rider on ATV on Control section

Dust inspector observing for opacity

Dust inspector observing for opacity

Appendix H

Test Location Map
(not to scale)