Environmental Data

EnviroKleen®
Synthetic Organic Dust Control®

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Environmental Perspective

Midwest Industrial Supply, Inc. is committed to providing comprehensive and relevant environmental information about our products. Working with various testing laboratories and regulatory organizations enables us to provide unbiased environmental and toxicity data that we use to develop the best dust control and stabilization programs for our customers.

Choosing the right product for an application is more that picking the product with good or sufficient dust control efficiency. It means evaluating the application and understanding all the needs of the customer including environmentally sensitive areas, regulatory constraints, aesthetics, customer preferences, operational or process concerns, and climate. Understanding the environmental and toxicity data and relating it to typical applications and site-specific needs is an important aspect of what Midwest does when working with our customers.

The conclusion of the information presented herein is that all testing shows EnviroKleen®, when applied properly, will not negatively impact soil quality or water quality in terms of toxicity. Generic risk assessment will not replace a conscientious site-specific evaluation, but the data used in this perspective is a necessary component for all risk assessments

The US EPA Environmental Technology Verification (ETV) Program protocol for Dust Suppression Products evaluated bulk constituents as well as aquatic toxicity on EnviroKleen®. The purpose of the program was to verify the level of dust control (particulate matter, PM, control efficiency) of EnviroKleen® and accumulate environmental data. The US EPA protocol did not allow for commentary on the environmental data.

The US EPA does however have regulatory guidelines that enable us to assess the potential impact of EnviroKleen® on the environment. The test results used for this Environmental Impact Perspective can be found in Appendix A and B of the US EPA ETV report on EnviroKleen® or on the Midwest Website.

1. Tri-State Laboratories, Chemical Analysis, July 2002
2. ABC Laboratories, Various Species Toxicity, September 2002
3. ABC Laboratories, Rainbow Trout Toxicity, September 2003

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Chemically, EnviroKleen® is a patent pending synthetic fluid. It is produced by a reaction of specific purified chemical feedstock that is treated via extreme heat, pressure and catalyst during hydrocracking, hydrotreating and hydroisomerization to create a synthetic iso-alkane. Further formulating and blending with purified polyolefins impart the rheological and cohesive properties unique to EnviroKleen®. EnviroKleen® is a non-aqueous liquid that is not water soluble or dilutable.

Application rates vary with soil type and properties and the desired end result of the project. EnviroKleen® is applied topically to the surface of the road with specially designed applicator trucks. Typical application rates range from 0.09 gal/yd2 to 0.30 gal/yd2. For purposes of this environmental impact analysis the application used in calculations was 0.40 gal/yd2, the same total application as that used in the dust control efficiency analysis at Fort Leonard Wood in October 2003.

A full range chemical analysis was performed on EnviroKleen® by Tri-State Labs. Composition analysis included: volatile organic compounds (VOC), semivolatile organic compounds (SVOC), metals, herbicides/herbicides and polynuclear aromatic hydrocarbons (PAH). Please see TSL, September 2003 for full analysis. The only chemicals detected in EnviroKleen® are four metals.

The US EPA has developed Risk Based Concentrations (RBC) tables for numerous toxic chemicals. These tables list the levels in various media (i.e.: fish, tap water, ground water, ambient air, industrial soil and residential soil) that a chemical can be present in that media and impart little if any risk to humans. The October 2005 Risk Based Concentrations (RBC) Table from EPA Region III was used in this evaluation. The EnviroKleen® application rate used was 0.40 gal/yd2, one (1) inch depth penetration was assumed and a soil density of 2.8 g/cm3 was used for calculations. Chemical level in the soil was compared to the RBC levels in residential soil. Analysis shows that at a heavy application of EnviroKleen®, for all detected constituents, the levels are significantly lower than the RBC levels in residential soil. Therefore, EnviroKleen® is safe for use in terms of environmental impact. The results are tabulated in the table below.

Chemical Constituent	**EnviroKleen® Level (mg/kg)**	**Soil Level (mg/kg)**	**RBC level (mg/kg)**
Aluminum	1.000	0.0214	78,000
Iron	25.000	0.5350	23,000
Manganese	0.120	0.0026	1,600
Zinc	0.137	0.0030	23,000

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Toxicological evaluation of EnviroKleen® utilized EPA methods for both acute and chronic toxicity determination for aquatic organisms. LC50 values were determined for each of the species. The table below contains a synopsis of the results.

EnviroKleen Aquatic Toxicity Test Results

*Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, EPA/600/4-90/027F.

*Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, EPA/600/4-91/002.

*Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Marine and Estuarine Organisms, EPA/600/4-91/003.

	Ceriodaphnia dubia	Fathead minnow	Americamysis bahia	Rainbow Trout
ACUTE/SURVIVAL (mg/L)				
LC50	>1000	>1000	>1000	>1000
NOEC	1000	1000	1000	1000
LOEC	>1000	>1000	>1000	>1000
CHRONIC/SURVIVAL (mg/L)				
LC50	>1000	>1000	>1000	>1000
NOEC	1000	1000	1000	1000
LOEC	>1000	>1000	>1000	>1000
CHRONIC/GROWTH/ REPRODUCTION (mg/L)				
LC50	>1000	>1000	>1000	>1000
NOEC	1000	1000	1000	1000
LOEC	>1000	>1000	>1000	>1000

See attached test results:
1. ABC Laboratories, Inc. Americamysis bahia, Fathead minnow, Ceriodaphnia dubia.
2. ABC Laboratories, Inc. Rainbow trout

LC50 -Lethal Concentration, 50%
NOEC - No Observable Effects Concentration
LOEC - Lowest Observable Effects Concentration

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The LC50 level is the lethal concentration of the chemical under test that kills 50% of the test organisms in the specified amount of time. According to the EPA-540-9-85-006, suggested toxicity criteria for materials are listed in the table below.

LC50 (mg/L)	**Category Description**
<0.1	Very highly toxic
0.1 – 1	Highly toxic
1 – 10	Moderately toxic
10 –100	Slightly toxic
>100	Practically non-toxic

Comparison of the EPA guidelines to the LC50 levels of all species show that EnviroKleen® is practically non-toxic to all species. In conclusion, all testing shows that EnviroKleen®, when applied properly, will not negatively impact soil quality or water quality in terms of toxicity. Generic risk assessment will not replace a conscientious site-specific evaluation, but the data used in this perspective is a necessary component for all risk assessments.

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Environmental Technology Verification Report

Dust Suppressant Products

Midwest Industrial Supply, Inc.'s EnviroKleen

Prepared by:

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Midwest Research Institute

EPA Cooperative Agreement No. CR829434-01-1
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Notice

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* RTI International is a trade name of Research Triangle Institute.

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A draft report with additional information on environmental and toxicological analysis conducted by the Civil Engineering Research Foundation (CERF) may be obtained from Midwest Industrial Supply, Inc.

For more information on verification testing of dust suppressant and soil stabilization products, contact:

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Abstract

Dust suppressant products used to control particulate emissions from unpaved roads are among the technologies evaluated by the Air Pollution Control Technology (APCT) Verification Center, part of the U.S. Environmental Protection Agency's Environmental Technology Verification (ETV) Program. The critical performance factor for dust suppressant verification is the dust control efficiency (CE). CE was evaluated in terms of total particulate (TP), particulate matter less than or equal to 10 micrometers (µm) in aerodynamic diameter (PM_{10}), and particulate matter less than or equal to 2.5 µm in aerodynamic diameter ($PM_{2.5}$).

Midwest Industrial Supply, Inc., submitted the EnviroKleen dust suppressant to the APCT Center for testing. The test/quality assurance (QA) plans, prepared in accordance with the Generic Verification Protocol (GVP), addressed the site-specific issues associated with these 1-year verification tests. The 1-year testing was conducted at two sites: Fort Leonard Wood, Missouri, and Maricopa County, Arizona. Testing at Fort Leonard Wood was conducted during October 2002, May 2003, and October 2003. Testing at Maricopa was conducted during May 2003 and August 2003. This verification report summarizes the results of the 1-year test. The verified CE will be based on all tests at each site, as specified in the test/QA plans. Test conditions were measured and documented.

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List of Acronyms/Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADT	average daily traffic
ANOVA	analysis of variance
APCT	air pollution control technology
AZMET	Arizona Meteorological Network
BOD	biological oxygen demand
CE	control efficiency
cfm	cubic feet per minute
CI	confidence interval
cm	centimeters
COD	chemical oxygen demand
DQO	data quality objective
DPW	Directorate of Public Works
EC_{50}	effective concentration, 50 percent
EPA	U.S. Environmental Protection Agency
ETV	environmental technology verification
FLW	Fort Leonard Wood, Missouri
ft	feet
g	grams
g/mL	grams per milliliter
gal	gallons
GPS	global positioning system
GVP	generic verification protocol
hi-vol	high volume
in	inches
km	kilometer
l or L	liters
lb	pounds
LC_{50}	lethal concentration, 50 percent
LOEC	lowest observed effective concentration
lpm	liters per minute
µg	micrograms
µm	micrometer
m	meters
MC	Maricopa County, Arizona
mg	milligrams
min	minutes
ml	milliliters
mph	miles per hour
MRI	Midwest Research Institute
MSDS	material safety data sheet
NA	not applicable
NOEC	no observed effect concentration
PM	particulate matter

PM_{10}	particulate matter equal to or less than 10 µm in aerodynamic diameter
$PM_{2.5}$	particulate matter equal to or less than 2.5 µm in aerodynamic diameter
QA	quality assurance
QC	quality control
RSD	relative standard deviation
RTI	RTI International
s	seconds
TA	training area
TCLP	toxicity characteristic leaching procedure
TP	total particulate
WAF	water accommodated fractions
yd	yard

1.0 Introduction

The objective of the Air Pollution Control Technology (APCT) Verification Center, part of the U.S. Environmental Protection Agency's (EPA's) Environmental Technology Verification (ETV) Program, is to verify, with high data quality, the performance of air pollution control technologies. One such set of air pollution control technologies consists of products used to control dust emissions from unpaved roads. Dust suppressant products, in general, are designed to alter the roadway by lightly cementing the particles together or by forming a surface that attracts and retains moisture. Control of dust emissions from unpaved roads is of increasing interest, particularly related to attainment of the ambient particulate matter (PM) standard. The U.S. Environmental Protection Agency (EPA) issued a new ambient standard for PM in 1997 that specifies new air quality levels for particulate matter less than or equal to 2.5 micrometers (μm) in aerodynamic diameter ($PM_{2.5}$).[1]

The APCT Center's verification of dust suppression products started with a preliminary 3-month testing program at Fort Leonard Wood, Missouri (FLW). The objective of this preliminary test program was to develop a cost-effective technique to measure the relative performance of dust suppressant products. The more common, but resource intensive, exposure profiling method to measure fugitive dust was compared to a mobile dust sampler. It was concluded that the mobile dust sampler could be used for future testing. A total of seven dust suppressant products were evaluated in the preliminary testing. Seven reports documenting the performance of these products were finalized in November 2002.[2]

After completion of the preliminary study, a 1-year field test program was designed by RTI and Midwest Research Institute (MRI) to evaluate the performance of dust suppressant products. Five dust suppressants manufactured or distributed by three firms were tested in this program. One of those dust suppressants was EnviroKleen developed by Midwest Industrial Supply, Inc. EnviroKleen is a synthetic organic dust control agent. The material safety data sheet (MSDS) for EnviroKleen indicates that it is a hydrotreated, hydrocracked, hydroisomerized, high-viscosity synthetic iso-alkane. The MSDS for EnviroKleen is retained in the RTI project files and is available on Midwest Industrial Supply's Web site (http://www.midwestind.com/problemsolver/productmaterials/EKMSDS.pdf) [accessed July 2005].

The field test program for EnviroKleen was conducted at two sites: FLW and Maricopa County (MC), Arizona. In July 2003, test and quality assurance (QA) plans for the field testing at FLW and MC were developed and approved by EPA.[3,4] The July 2003 versions of each test/QA plan were based on an October 2002 version and a subsequent test/QA plan addendum (dated February 19, 2003, for FLW, and February 10, 2003, for MC). These test/QA plans describe the procedures and methods used for the tests. The goal of each test was to measure the performance of the products relative to uncontrolled sections of road over a 1-year period. Field testing was planned quarterly over a 1-year period; however, some logistical difficulties related to the weather and maintenance activities on the roads of interest arose, and the test/QA plans were modified (Rev 3) to address these issues. At FLW, test periods occurred per the test/QA plan for three roughly 6-month periods during October 2002, May 2003, and October 2003. At

MC, testing was conducted per the test/QA plans for only two quarterly test periods, during May 2003 and August 2003. Emissions measurements were made for total particulate (TP), particulate matter less than or equal to 10 µm in aerodynamic diameter (PM_{10}), and for $PM_{2.5}$.

This report contains only summary information and data from the 1-year test program, as well as the verification statement related to the dust control efficiency (CE) measured for EnviroKleen during testing at FLW and MC. Complete documentation of the test results is provided in a separate test report[5] for FLW and MC and a data quality audit report.[6] Those reports include the raw test data from product testing and supplemental testing, equipment calibration results, and QA and quality control (QC) activities and results. Complete documentation of QA/QC activities and results, raw test data, and equipment calibration results are retained in MRI's files for 7 years.

The results of the tests are summarized and discussed in Section 2. The conditions in which the tests were conducted are presented in Section 3, and references are presented in Section 4.

2.0 Summary and Discussion of Results

Verification tests were conducted over a 1-year period on Midwest Industrial Supply's EnviroKleen dust suppressant as applied to unpaved roads at FLW and MC. Original plans called for testing to occur on a quarterly basis; however, one quarterly test was abandoned due to persistently unfavorable wintertime weather at FLW. In addition, at MC, the original test site (Lower Buckeye Road) was disturbed after the original treatment. As a result, a 6-month (rather than 1-year) verification study was conducted with quarterly measurements at a second site (Broadway Road) in MC.

The mobile dust sampling system used in this test program provides quantitative information on relative emissions levels. The mobile system consists of a high-volume (hi-vol) PM_{10} cyclone combined with a $PM_{2.5}$ cyclone. The sampler inlet sits above the densest portion of the dust plume, immediately behind the test vehicle. In this location, the sampler collects PM that is truly airborne. The hi-vol sampler is operated with a nozzle matched to the test vehicle's travel speed to best approximate isokinetic sampling. The test plans provide additional details on the construction and operation of the mobile sampler.

The results of the quarterly tests are summarized in Section 2.1. The results of laboratory toxicity tests on the product are included in Section 2.2. The results of QC checks performed during these quarterly tests are summarized in Section 2.3. Deviations from the test plans are discussed in Section 2.4.

2.1 Verification Results

Tables 1 and 2 present summary statistics for results from each test period. The mobile sampler provides a test result in terms of particulate mass collected per distance traveled [milligrams per 1,000 feet (mg/1,000 ft)]. The tables show the number of days after product

application, the mean controlled and uncontrolled emissions values, and the resulting CEs. The relative standard deviation (RSD) for the emissions values is shown in parentheses.

The uncontrolled and controlled emissions values for the mobile dust sampler are means of five replicate measurements. Each of the five replicate measurements consisted of twelve passes over a 500-ft length test section of the treated road segment, to total approximately 6,000 ft of distance covered. Detection limits were set at two standard deviations above the average filter blank correction for sample mass. Values below the detection limits (quantification level) were included in the averaging process at half the detection limit.

Table 1 presents data for the test periods when no unexpected road maintenance occurred between product application and testing. These data are considered the most representative of the product's performance. Table 2 presents data when unexpected road maintenance occurred. These data provide an example of performance under the described circumstances.

Table 1. Summary of Test Results for EnviroKleen (No Road Maintenance)

Test period	Uncontrolled emissions, mg/1,000 ft *(RSD, %)*			Time since last application, days	Controlled emissions, mg/1,000 ft *(RSD, %)*			Control efficiency, %		
	TP	PM_{10}	$PM_{2.5}$		TP	PM_{10}	$PM_{2.5}$	TP	PM_{10}	$PM_{2.5}$
FLW										
October 2003[a]	7.9	0.68	1.5	120	1.5	0.15	1.2	81	>87	20
	(59)	*(78)*	*(27)*		*(39)*	*(44)*	*(11)*			
May 2003[b]	9.1	1.2	0.71	77	<0.14[c]	0.02	<0.07[c]	>99	>98	>90
	(14)	*(21)*	*(29)*		*(0.0)*	*(1.8)*	*(0.0)*			
MC										
May 2003	50	14	3.7	70	11	1.2	0.49	78	91	87
	(76)	*(84)*	*(65)*		*(68)*	*(59)*	*(41)*			

[a] All test sections were wet from rain the previous day. The uncontrolled section was heavily potholed and another section was used for the test. MRI used traffic to dry the road before testing.

[b] Rainfall in the morning meant that the uncontrolled section of the road was wet and another section was used for the test.

[c] All values were below the detection limit.

Table 2. Summary of Test Results for EnviroKleen (After Road Maintenance Occurred)

Test period	Uncontrolled emissions, mg/1,000 ft *(RSD, %)*			Time since last application, days	Controlled emissions, mg/1,000 ft *(RSD, %)*			Control efficiency, %		
	TP	PM_{10}	$PM_{2.5}$		TP	PM_{10}	$PM_{2.5}$	TP	PM_{10}	$PM_{2.5}$
FLW										
October 2002[a]	9.5	2.3	2.5	127	6.0	0.63	<0.65[b]	37	72	>74
	(36)	*(55)*	*(41)*		*(32)*	*(96)*	*(0.0)*			
MC										
August 2003[c]	74	24	4.5	84	55	16	1.0	25	34	77
	(34)	*(47)*	*(37)*		*(69)*	*(49)*	*(53)*			

[a] Unexpected road maintenance activity occurred at FLW in September 2002 prior to the October 2002 test series. After consideration, it was decided to continue with planned testing; however, in retrospect, the treated surface evaluated during this test series was not representative, and controlled values from the test series should be viewed as conservatively low.

[b] All values were below the detection limit.

[c] Unexpected road maintenance activity appeared to have occurred at MC after the time of the May 2003 visit and prior to the August 2003 test series. The entire test road appeared to have been bladed. The vendor interviewed persons living near the test site who remarked that the road had been bladed prior to the test visit. In this case, the control efficiency values from this test series should be viewed as conservatively low.

The dust emissions CE is calculated as follows:

$$CE = 100 \times (e_{um} - e_{cm})/e_{um} \qquad \text{Eq. 1}$$

where:

CE = control efficiency (percent)

e_{um} = uncontrolled emissions value expressed as sample mass divided by the cumulative length of road traveled by the mobile sampler (mg/1,000 ft)

e_{cm} = controlled emissions value expressed as sample mass divided by the cumulative length of road traveled by the mobile sampler (mg/1,000 ft).

Control efficiencies can vary considerably between test periods, and some of the variation can be related to two factors: the time since the most recent application and the application rate of the dust suppressant. A complete history of the test road treatment is given in Section 3.2. The time since the most recent application is shown in Tables 1 and 2, in addition to information on road maintenance activities and rainfall. Beyond the application rate and the time since application factors, additional variation can arise from changing site conditions. For example, unplanned road maintenance occurred at both sites, as noted in Table 2. In addition, precipitation before or during a field testing campaign could cause variation in both uncontrolled and controlled test results. That is to say, measured emissions could change after precipitation so that back-to-back tests would not necessarily be "replicates" in the sense of having identical

test conditions. MRI always attempted to dry the road with traffic to the point that it appeared visibly dry before beginning a test period.

2.2 Laboratory Toxicity Test Results

A sample of EnviroKleen was taken when the product was applied at FLW. The product was sent to ABC Laboratories, Columbia, Missouri, and to Tri-State Laboratories, Inc., Youngstown, Ohio, for analysis. The following test methods were used in accordance with the test/QA plan:[3]

- **Environmental/Chemical Testing**
  - EPA Method 24[7] Volatile Organics
  - EPA Method 405.1[8] 5-day Biochemical Oxygen Demand (BOD) of product
  - EPA Method 410.4[9] Chemical Oxygen Demand (COD)
  - EPA Method 1311[10] Toxicity Characteristics Leaching Procedure (TCLP)
  - EPA Method 6010B[10] Inorganics/Metals
  - EPA Method 6010B[10] Title 22 Metals
  - EPA Method 8260B[10] Volatile Organics
  - EPA Method 8270[10] Semivolatile Organics
  - EPA Method 8270D[10] Semivolatile Organics
  - EPA Method 8270D[10] Pesticides and Herbicides

- **Effluent Toxicity Testing**
  - EPA600/4-90/027F[11] Acute toxicity: Water fleas lethal concentration, 50 percent (LC_{50}), Fathead minnow LC_{50}, and Mysid shrimp LC_{50}
  - EPA/600/4-91/002[12] Chronic Toxicity: Water fleas LC_{50}, Fathead minnow LC_{50}, and Mysid shrimp LC_{50}.

See Appendices A and B for the environmental and chemical test results, respectively.[13,14] RTI also conducted Method 24 tests on the product samples;[15] see Appendix C for these results.

2.3 Discussion of QA/QC

The testing process was based on the approved *Generic Verification Protocol for Dust Suppression and Soil Stabilization Products* (GVP);[16] the *Test/QA Plan for Testing of Dust Suppressant Products at Fort Leonard Wood, Missouri*, Rev 3 (July 24, 2003);[3] and the *Test/QA Plan for Testing of Dust Suppressant Products at Maricopa County, Arizona*, Rev 3 (July 24, 2003).[4] The MRI task leader and QA manager verified that the quality criteria specified in these test plans (Sections 3.4 and A4, respectively) were met (see Section 2.4) for the overall test (the within-site, -suppressant, and -particle size fraction variability was often higher than planned). Assessments specified in Section 8 of the GVP were performed. Reconciliation of the data quality objectives (DQOs) with test results is summarized in Table 3. Data from all three test

periods are included in the analysis, including those data collected during the test period following unexpected road maintenance.

Table 3. DQOs versus Final Control Efficiency Variability for EnviroKleen

		Number of test periods	Final CE, fractional	90% Confidence Interval			DQO[a]	Is the half-width interval less than the DQO (i.e., DQO met)?
				Lower limit	Upper limit	Half width		
TP	FLW	3	0.72	0.67	0.77	0.053	0.064	Yes
	MC	2	0.51	0.43	0.59	0.078	0.11	Yes
PM_{10}	FLW	3	0.86	0.83	0.88	0.027	0.033	Yes
	MC	2	0.62	0.56	0.69	0.066	0.086	Yes
$PM_{2.5}$	FLW	3	0.60	0.51	0.68	0.085	0.093	Yes
	MC	2	0.82	0.79	0.85	0.028	0.041	Yes

[a] Final CE DQO is interpolated from Table 6 of the test/QA plans using the equation:
Half width DQO = -0.2295 CE + 0.22972.

In all cases, the testing process and the resulting data were determined by the MRI QA manager to have met the specified quality criteria, although there were significant uncontrollable plan deviations related to field conditions.

The RTI quality manager has reviewed the above information (including the deviations from the test plan, noted in Section 2.4), has sampled the data against the specified criteria, and concurs with the MRI assessment that the DQOs were met for the overall test. The APCT director has determined that the data are usable as intended in the planning documents.

2.4 Deviations from Test Plan

Significant deviations from the test/QA plan are discussed below and are shown in Tables 4 and 5 for FLW and MC, respectively. Changes in the application dates are also summarized in the tables.

The FLW test/QA plan stated that background PM concentration values would be collected from an ambient PM monitor; however, the monitoring station in question collects only meteorological data and does not contain a PM monitor. Therefore, MRI operated a background PM sampler at the Range 12 building [located approximately 1 kilometer (km) east of the test section] where line electrical power was available.

Table 4. Summary of Test Event Deviations for FLW

Project activities	Planned date	Actual date	Test series[a]
Unexpected road maintenance	Not planned	September 16, 2002	Not applicable (NA)
End of 1st test period	September 2002	October 12–14, 2002	5U, 5C
Suppressant reapplication	September 2002	October 18–28, 2002	NA
End of 2nd test period	January 2003	Not performed because of consistently bad weather	None, per modified Test/ QA plan
Suppressant reapplication	January 2003	March 8, 2003	NA
End of 3rd test period	April 2003	May 24–26, 2003	5U, 5C
Suppressant reapplication	April 2003	June 14, 2003	NA
Road traffic increased with construction	Not planned	July 21–October 10, 2003	NA
End of 4th test period	July 2003	October 10–12, 2003	5U, 5C

[a] 5U means five uncontrolled replicate measurements; 5C means five controlled replicate measurements.

Table 5. Summary of Test Event Deviations for MC[a]

Test event deviations	Planned	Actual	Test series[b]
Initial suppressant application, site #2	February 2003	March 5, 2003	NA
End of 1st test period	May 2003	May 13–15, 2003	5U, 5C
Suppressant reapplication	May 2003	May 14, 2003	NA
Unexpected road maintenance	Not planned	Late July 2003	NA
End of 2nd test period	August 2003	August 6–7, 2003	5U, 5C

[a] Due to early, unauthorized test road disturbance, this summary is based on Rev 3 of the test/QA plan, which specified 6 months of testing (two quarterly test periods).
[b] 5U means five uncontrolled replicate measurements; 5C means 5 controlled replicate measurements.

The FLW and MC test/QA plans stated that the CE "will be determined relative to its decay over time and with traffic." Because the vendor chose to reapply the dust suppressants following each test period, this was not achievable. At least three test series between applications would have been required to calculate a CE decay rate. Moreover, the decay rate would have changed from application to application because of the increasing inventory of dust suppressant in a specific road segment.

The projected schedule for the dust suppressant tests at FLW called for four quarters of planned tests starting in June 2002. The time between test series was originally planned to be approximately 90 days, to represent seasonal differences in CE; however, not all of the planned four quarters of testing were conducted. Testing was conducted for three 6-month periods at FLW and was conducted for two quarterly test periods at MC.

As noted earlier, damage to the original controlled test section led to the revision of the MC test/QA plan. This revised plan substituted a 6-month study, with test periods in May and August, in place of the original year-long verification program and four test periods.

Both the FLW and MC test plans mentioned a pneumatic traffic counter and a data logger for on-site wind measurements; however, neither of these was deployed during the test program. Instead, training records supplied by the Army were used to estimate the total convoy traffic during the field program at FLW. Maricopa County Department of Transportation personnel were asked to provide an estimate for the average daily traffic (ADT) value for the Arizona test site. Traffic data are described in Section 3.1.1. The Army supplied meteorological records for both the Forney Army Airfield (located within 5 km of the test site) and the Bailey wind station (located immediately west of the test site). Meteorological data for the MC site were obtained through AZMET (Arizona Meteorological Network) for a station 12 km to the east of the Broadway test site. Meteorological data are described in Section 3.1.2.

Deviations during the individual test periods at FLW and in MC are discussed in the following paragraphs.

October 2002 Test Period at FLW. Both the field tests and the reporting of results occurred later than originally called for in the test/QA plan. The delay in testing was directly due to the unexpected road maintenance during the week of September 16, 2002, which occurred at the request of a Directorate of Public Works (DPW) contractor. This action required a delay of approximately 2 weeks to assess the extent to which the treated surface had been affected and whether testing of the surface would produce results useful to the program. Based on anecdotal information from the grader operator as well as photograph of the surface, it was determined that the surface had been covered with loose material (pulled from the side of the road). Subsequent discussions between DPW, the product vendors, RTI, and MRI led to general agreement to continue with conducting a first series of tests in October 2002.

January 2003 Test Period at FLW. As noted above, persistently unfavorable winter weather during January and February 2003 forced the abandonment of the second quarterly test.

May 2003 Test Period at FLW. During the field audit conducted on May 26, 2003, it was determined that the $PM_{2.5}$ background monitor operated at a flow of approximately 9 liters per minute (lpm) [0.32 cubic feet per minute (cfm)] rather than the target of 16.7 lpm (0.59 cfm). Because the background concentration was used only to estimate the maximum contribution that ambient PM levels could contribute to the mass collected by the mobile sampler, the contribution for $PM_{2.5}$ was conservatively estimated using the PM_{10} background level. This point is discussed further in Section 3.1.

Another deviation concerned the location of the uncontrolled test section during the May 26, 2003, tests. On that day, a portion of uncontrolled test section (Section F in the test plan) was still damp from rain during the morning of May 25. For that reason, an uncontrolled 150-m (500-ft) section farther west along the same road was substituted.

October 2003 Test Period at FLW. Both the field tests and the reporting of results occurred later than originally called for in the test/QA plan. The delay in testing was due to rainfall over Labor Day weekend. Testing was rescheduled for Columbus Day weekend. No quarterly test report was prepared pending preparation of the final report.

Rainfall on the day before MRI's arrival left all sections damp. In addition, the uncontrolled test site (Section F) was so heavily potholed that the mobile sampler could not be safely operated at the designated vehicle speed. Uncontrolled tests were moved to an untreated section of the same road to the west that exhibited better drainage than Section F. As noted earlier, MRI used traffic to dry the road before beginning a test series.

May 2003 Test Period at MC. The speedometer on the test vehicle was inoperative because of a fuse problem. For that reason, vehicle speed was monitored using a new handheld global positioning system (GPS) unit. The GPS readings were checked against a rental car's speedometer and were found to agree within 2 miles per hour (mph) at 25 and 35 mph.

A filter used on test run CKO-131 did not pass initial audit during the tare weighing, but was not reweighed as required by MRI SOP-8403.

August 2003 Test Period at MC. No quarterly report was prepared for this test period, pending preparation of the final report. Test speeds were monitored using the same handheld GPS as used during the May 2003 tests. Some unexpected road maintenance appeared to have occurred since the time of the May 2003 visit. The entire test road in MC appeared to have been bladed. The vendor interviewed persons living near the test site who remarked that the road had been bladed prior to the test visit.

3.0 Test Conditions

3.1 General Test Site Conditions

The test/QA plans for FLW and MC document the sites and road sections used during dust suppressant testing.

One of the host facilities for the field test program, FLW, is a U.S. Army base. The test site at FLW used unpaved Roads P and PA in training area (TA) 236. Roads P and PA are the main access routes to TA 236 and are traveled by truck convoys, as well as traffic into and out of TA 236. Test sections A, B, C, and D are located on Road PA, while test section E is located along Road P. EnviroKleen was applied to test section B. Other products tested during this program were applied to the other test sections. The sixth test section (F), also located on Road P, was left untreated as the experimental control. Figure 1 shows the test locations at FLW.[3]

The other host facility for the field test program, MC, is located on Broadway Road (a county road) near the towns of Buckeye and Wintersburg, Arizona. The sections used for dust suppressant testing were on portions of the road constructed of shale. The road typically experiences approximately 150 vehicle passes per day, with the majority of passes by light-duty cars and trucks. Much of the traffic appears to be associated with local residents commuting to their workplaces and thus occurs during the early morning and late afternoon hours. Test sections were located on Broadway Road east of 355thAvenue. EnviroKleen was evaluated on the section immediately east of 355th Avenue. The uncontrolled measurements were conducted on a separate section of Broadway Road. Figure 2 shows the test locations at MC.[4]

Figure 1. Test locations at FLW

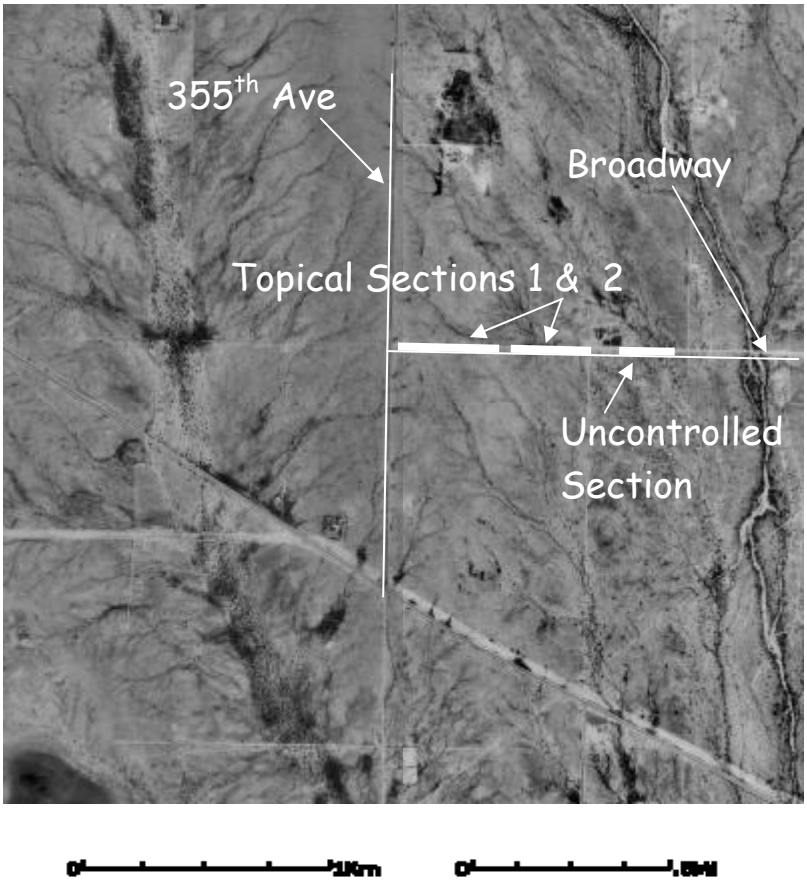

Figure 2. Test locations at MC

3.1.1 Traffic

All sections of the test site at FLW were exposed to military traffic, consisting of 2.5- and 5-ton trucks, as well as sport-utility type vehicles (such as Chevrolet Blazers). This traffic occurred during training days (typically Monday through Friday). Based on records supplied by the Army, an estimated 3,650 convoy vehicles traveled over the test surface during the entire field program. This does not include other Army-related traffic, for which records are not kept. Furthermore, additional light-duty vehicular traffic took place due to recreational use of the fort during weekends. Finally, an additional 60 passes by a Ford F-250 pickup occurred during each of the test periods. (Note that testing took place on days with no scheduled Army training activities.)

From July 21, 2003, to the final test series in October 2003, the EnviroKleen test section at FLW experienced additional traffic associated with construction activities in TA 236. This traffic, which occurred Monday through Friday, averaged 40 loaded (27 ton) dump truck passes, 40 empty (11 ton) dump truck passes, and 30 to 50 car/pickup passes per day.

The Arizona test section was exposed to the naturally occurring traffic along Broadway Road in MC. Traffic consisted mostly of light-duty vehicles such as cars and pickups, with a

few passes by school buses during weekdays. Based on the county's plans to pave the road in the future, an approximate value of 200 ADT can be applied to the test section. (The ADT level was measured at 247 in March 2004, approximately 7 months after the conclusion of the field measurements.) An additional 60 to 120 passes by a Ford F-150 pickup occurred during each of the test periods.

3.1.2 Area Climatic Conditions

Table 6 presents the weekly weather over the entire FLW verification period (i.e., from June 2002 when the product was first applied until the final set of tests in October 2003). These data were collected at Forney Airfield, which is located approximately 5 km (3 miles) north-northeast from the test section. (Note that the Forney station operating hours were 0600–2100 Monday through Friday, 0700–1500 Saturday, and 1100–1900 Sunday. The temperature extremes are officially valid for those timeframes.)

Table 6. Weekly Weather for FLW

Site weather				
Week beginning	Air temp, ºC (°F)		Precipitation, cm (in.)	
	Maximum	Minimum	Liquid	Frozen
06/02/02	32 (90)	13 (56)	2.2 (0.88)	0 (0)
06/09/02	31 (87)	14 (58)	1.2 (0.48)	0 (0)
06/16/02	33 (91)	13 (56)	0 (0)	0 (0)
06/23/02	33 (92)	19 (66)	0.61 (0.24)	0 (0)
06/30/02	33 (92)	20 (68)	2.0 (0.79)	0 (0)
07/07/02	36 (97)	20 (68)	1.0 (0.41)	0 (0)
07/14/02	35 (95)	18 (64)	0.03 (0.01)	0 (0)
07/21/02	37 (98)	19 (67)	2.6 (1.0)	0 (0)
07/28/02	37 (99)	21 (69)	0.03 (0.01)	0 (0)
08/04/02	36 (97)	16 (61)	0.2 (0.07)	0 (0)
08/11/02	31 (87)	18 (64)	4.1 (1.6)	0 (0)
08/18/02	33 (92)	20 (68)	0.89 (0.35)	0 (0)
08/25/02	29 (85)	17 (62)	0 (0)	0 (0)
09/01/02	31 (88)	17 (63)	0 (0)	0 (0)
09/08/02	32 (90)	14 (58)	0 (0)	0 (0)
09/15/02	31 (87)	17 (63)	3.6 (1.4)	0 (0)
09/22/02	27 (81)	8 (46)	0 (0)	0 (0)
09/29/02	32 (89)	16 (60)	0.58 (0.23)	0 (0)
10/06/02	20 (68)	5 (41)	0.48 (0.19)	0 (0)
10/13/02	18 (64)	1 (33)	0.56 (0.22)	0 (0)
10/20/02	19 (67)	2 (36)	5.1 (2.0)	0 (0)
10/27/02	11 (52)	0 (32)	4.1 (1.6)	0 (0)
11/03/02	22 (71)	2 (36)	1.8 (0.72)	0 (0)
11/10/02	18 (64)	-2 (28)	1.7 (0.65)	0 (0)
11/17/02	18 (65)	0 (32)	0 (0)	0 (0)

(continued)

Table 6. (continued)

Site weather				
Week beginning	Air temp, ºC		Precipitation, cm (in.)	
	Maximum	Minimum	Liquid	Frozen
11/24/02	16 (61)	-6 (21)	0.03 (0.01)	0 (0)
12/01/02	15 (59)	-9 (15)	1.7 (0.68)	16 (6.2)
12/08/02	11 (52)	-4 (24)	0.38 (0.15)	0 (0)
12/15/02	18 (65)	1 (33)	3.7 (1.4)	0 (0)
12/22/02	4 (40)	-12 (11)	3.4 (1.4)	34 (14)
12/29/02	18 (65)	-7 (19)	1.3 (0.52)	0.8 (0.3)
01/05/03	21 (70)	-6 (22)	0.43 (0.17)	0 (0)
01/12/03	6 (43)	-14 (7)	0.33 (0.13)	4.8 (1.9)
01/19/03	13 (56)	-19 (-2)	0.43 (0.17)	4.3 (1.7)
01/26/03	19 (67)	-10 (14)	0.38 (0.15)	0 (0)
02/02/03	23 (74)	-15 (5)	0.69 (0.27)	7.9 (3.1)
02/09/03	14 (57)	-4 (24)	2.7 (1.1)	2 (0.9)
02/16/03	12 (54)	-6 (22)	2.1 (0.83)	0.3 (0.1)
02/23/03	4 (40)	-14 (6)	1.7 (0.66)	18 (7.2)
03/02/03	24 (76)	-7 (20)	0.05 (0.02)	0 (0)
03/09/03	25 (77)	-8 (17)	1.7 (0.66)	0 (0)
03/16/03	22 (72)	4 (39)	3.6 (1.4)	0 (0)
03/23/03	25 (77)	0 (32)	2 (0.7)	0 (0)
03/30/03	29 (85)	2 (35)	0.03 (0.01)	0 (0)
04/06/03	27 (81)	0 (32)	4.7 (1.8)	0 (0)
04/13/03	29 (85)	9 (48)	0.91 (0.36)	0 (0)
04/20/03	22 (71)	5 (41)	4.2 (1.7)	0 (0)
04/27/03	30 (86)	10 (50)	1.7 (0.67)	0 (0)
05/04/03	30 (86)	14 (57)	2.3 (0.92)	0 (0)
05/11/03	26 (79)	9 (48)	3.2 (1.3)	0 (0)
05/18/03	26 (79)	9 (48)	2.1 (0.83)	0 (0)
05/25/03	31 (87)	9 (48)	1.6 (0.63)	0 (0)
06/01/03	25 (77)	9 (48)	3.7 (1.4)	0 (0)
06/08/03	28 (83)	13 (56)	6.6 (2.6)	0 (0)
06/15/03	29 (84)	14 (57)	2(0.6)	0 (0)
06/22/03	32 (90)	13 (56)	2.6 (1.0)	0 (0)
06/29/03	34 (94)	19 (66)	0 (0)	0 (0)
07/06/03	34 (93)	17 (63)	1.2 (0.46)	0 (0)
07/13/03	36 (96)	21 (69)	3.9 (1.5)	0 (0)
07/20/03	35 (95)	14 (58)	0.03 (0.01)	0 (0)
07/27/03	37 (98)	17 (63)	4.0 (1.6)	0 (0)
08/03/03	33 (91)	18 (64)	0.1 (0.04)	0 (0)
08/10/03	34 (94)	18 (65)	0.03 (0.01)	0 (0)
08/17/03	39 (102)	21 (69)	1.5 (0.59)	0 (0)
08/24/03	37 (98)	21 (69)	4.2 (1.6)	0 (0)

(continued)

Table 6. (continued)

Site weather				
Week beginning	Air temp, ºC (°F)		Precipitation, cm (in.)	
	Maximum	Minimum	Liquid	Frozen
08/31/03	28 (82)	12 (54)	6.4 (2.5)	0 (0)
09/07/03	31 (87)	14 (57)	2.0 (0.78)	0 (0)
09/14/03	29 (84)	7 (45)	3.3 (1.3)	0 (0)
09/21/03	29 (85)	11 (52)	3.8 (1.5)	0 (0)
09/28/03	20 (68)	4 (39)	1.7 (0.68)	0 (0)
10/05/03	24 (76)	8 (47)	1.8 (0.72)	0 (0)
10/12/03	23 (74)	8 (46)	0.2 (0.07)	0 (0)

Table 7 contains weekly weather data for the MC site for the period of March to August 2003. The meteorological data were taken at a station in Buckeye maintained by the Roosevelt Irrigation District. The station, located at latitude 33° 24’ north and longitude 112° 41’ west, lies approximately 12 km (8 miles) to the east of the Broadway test site.

Table 7. Weekly Weather for Buckeye, Arizona

Site weather			
Week beginning	Air temperature, ºC (°F)		Precipitation, cm (in.)
	Maximum	Minimum	
03/02/03	27 (80)	4 (40)	0 (0)
03/09/03	30 (86)	7 (45)	0 (0)
03/16/03	27 (81)	4 (39)	0.97 (0.38)
03/23/03	31 (88)	8 (47)	0 (0)
03/30/03	32 (90)	4 (40)	0 (0)
04/06/03	33 (91)	2 (35)	0 (0)
04/13/03	30 (86)	7 (44)	0.30 (0.12)
04/20/03	31 (88)	6 (42)	0 (0)
04/27/03	32 (90)	8 (47)	0 (0)
05/04/03	29 (85)	7 (44)	0 (0)
05/11/03	39 (102)	9 (48)	0 (0)
05/18/03	40 (104)	15 (59)	0 (0)
05/25/03	42 (108)	16 (60)	0 (0)
06/01/03	41 (105)	20 (68)	0 (0)
06/08/03	42 (107)	15 (59)	0 (0)
06/15/03	42 (108)	17 (62)	0 (0)
06/22/03	44 (111)	18 (64)	0 (0)
06/29/03	43 (110)	21 (70)	0 (0)
07/06/03	43 (109)	20 (68)	0 (0)
07/13/03	46 (115)	26 (79)	0.1 (0.05)
07/20/03	43 (109)	24 (75)	0.38 (0.15)
07/27/03	39 (103)	22 (72)	2.4 (0.96)
08/03/03	43 (109)	23 (74)	0 (0)

A summary of the precipitation for all the test periods at FLW and MC is shown in Table 8.

Table 8. Summary of Precipitation for All Test Periods at FLW and MC

Parameter	FLW, weekly precipitation range, cm	MC, weekly precipitation range, cm
Precipitation during test week	0.2–3.7	0
Precipitation during week before testing	0.58–3.2	0–2.4
Precipitation between application and testing, total	17–39	1.3–2.9

3.1.3 Background Particulate Concentration

During the FLW test series, TP and PM_{10} background concentrations were measured approximately 1 km (0.6 miles) east of the test site. Background concentration data are presented in Table 9.

Table 9. Measured Background PM Concentrations at FLW

Date	Concentration, µg/m^3	
	PM_{10}	TP
10/12/02	7.1	14
10/13/02	6.5	16
10/14/02	9.1	28
5/24/03	19	23
5/26/03	19	38
10/11/03	13	19
10/12/03	5.7	7.9
10/13/03	7.2	14
Average	11	20
Maximum	19	38

Because of the previously mentioned problem with the $PM_{2.5}$ background monitor at FLW (see Section 2.4), it was not possible to measure background $PM_{2.5}$ concentrations accurately. Therefore, the $PM_{2.5}$ concentration was assumed equal to the PM_{10} concentration value. This yielded a conservatively high estimate for the contribution of background PM concentrations to the $PM_{2.5}$ sample mass catches at FLW.

Estimates made of the contributions to net sampler catches at FLW by background concentrations of TP and PM_{10} are also conservatively high because estimates assume a 30-minute (min) sampling period. As noted in the test/QA plan, the hi-vol sampler is activated only when passing over the test section; 12 passes over a 500-ft test section at 25 mph is only 160 s or 2.7 min. The conservatively high estimates of background contributions to sampler

catches at FLW are compared to blank filter data in Table 10. Background mass contributions were estimated by multiplying background concentration times flow rate and sampling time to arrive at a mass collected that could have been contributed by ambient air.

Table 10. Estimated Background Contribution to Sampler Catch at FLW Compared to Mean Blank Filter Data

	Weight, mg		
	TP	**PM_{10}**	**$PM_{2.5}$**
Average estimated background contribution	0.67	0.37	0.0055
Average blank filter weight	2.5	2.2	0.029

The estimated background contributions are significantly lower than the mean blank filter masses collected at FLW. Thus, background PM contributed negligibly to the net catches for the mobile sampler. The Arizona Department of Environmental Quality (ADEQ) maintains the Palo Verde ambient air monitoring site at 36248 W. Elliott Road. The Palo Verde monitoring site is 16 km (10 miles) from the general test site area. PM_{10} and $PM_{2.5}$ are monitored on a one-day-in-six basis using reference method dichotomous samplers. The site was established to determine background concentrations on a regional scale.

The ADEQ provided the data in Table 11 for the Palo Verde site.

Table 11. Background Concentration Measurements at Palo Verde, Arizona

Date	**Concentration, µg/m^3**	
	PM_{10}	**$PM_{2.5}$**
5/9/03	24	9.0
5/15/03	103	20
5/21/03	41	12

Note that the May 15 and May 21, 2003, values represent the highest and second highest concentrations monitored at the Palo Verde site in 2003 through May 21. Conservatively high estimates of background contribution were developed for the MC site in the same manner as described above for FLW. Based on these assumptions**,** background particulate would account for no more than 3.5 mg of PM_{10} or 0.010 mg of $PM_{2.5}$ sample mass. The mean sample mass corresponding to the EnviroKleen entries in Tables 1 and 2 was more than five times higher than these maximum background contributions.

3.2 Application of Dust Suppressant

MRI observed and documented all steps in the various applications of the dust suppressant to the road test section. EnviroKleen is applied as received and requires no mixing with water for application. Table 12 presents the application intensity for both FLW and MC as determined through use of sampling pans located on a grid each time the product was applied.

Table 12. Application History

Date	Application intensity		Comments
	Mean, l/m^2 (gal/yd^2)[a]	**Standard deviation, l/m^2 (gal/yd^2)**	
FLW			
June 7–8, 2002	1.4 (0.30)	0.097 (0.021)	Applied in five passes, very even spray pattern. The final pass on June 8 applied 0.25 l/m^2. Value shown represents total of June 7 and 8 treatments.
October 26, 2002	0.27 (0.060)	0.097 (0.021)	Applied in two passes.
March 8, 2003	0.32 (0.071)	0.04 (0.009)	Applied in three passes.
June 14, 2003	0.43 (0.096)	0.04 (0.01)	Applied in four passes. Applied using pallet-mounted spray system housed in box truck.
MC			
March 5, 2003	0.83 (0.18)	0.050 (0.011)	Applied in four passes, very even spray pattern.
May 14, 2003	0.27 (0.061)	0.13 (0.028)	Applied in four passes, upon completion of the first quarterly test. Pull-behind trailer used rather than spray truck used in March 2003 application.

[a] The mean is based on the total amount applied to the surface of the road summed over all passes.

Three different pieces of spray equipment were used to apply the product. As noted in Table 12, the June 14, 2003, application at FLW and the May 14, 2003, application at MC relied on pallet- and trailer-mounted spray systems, respectively. All other applications were by a spray truck. Figure 3 shows application of EnviroKleen product at FLW, and Figure 4 shows application of product at MC.

Figure 3. Application of EnviroKleen product at FLW

Figure 4. Application of EnviroKleen product at MC

Treatment of the 270-m (900-ft) long road segment required approximately 1 man-hour using the spray truck. Treatment using the trailer- and pallet-mounted systems required approximately 50 percent more effort because of time required to set up the system.

3.3 Conditions During Dust Suppressant Test Runs

Table 13 presents the dates and times when dust suppressant testing was conducted at FLW and MC, including the length of road measured and meteorological conditions during each test run. As discussed previously, Tables 6 and 7 present the climatic conditions for the week during which the dust emissions tests were conducted.

Table 13. Test Run Parameters

Run	Test section	Date	Test start time	Total distance, m (ft)	Temperature, °C (°F)	Barometric pressure, mm Hg (in. Hg)
FLW						
CKO-2	Uncontrolled	10/12/02	10:36	1,829 (6,000)	22 (72)	745 (29.4)
CKO-13	Uncontrolled	10/12/02	16:50	1,829 (6,000)	23 (74)	744 (29.3)
CKO-23	Uncontrolled	10/13/02	17:14	1,829 (6,000)	13 (56)	753 (29.6)
CKO-24	Uncontrolled	10/14/02	9:28	1,829 (6,000)	13 (55)	749 (29.5)
CKO-35	Uncontrolled	10/14/02	16:21	1,829 (6,000)	19 (66)	747 (29.4)
CKO-211	Uncontrolled	05/24/03	16:15	1,829 (6,000)	24 (75)	733 (28.8)
CKO-212	Uncontrolled	05/24/03	16:40	1,829 (6,000)	26 (78)	733 (28.8)
CKO-230	Uncontrolled	05/26/03	16:16	1,829 (6,000)	26 (78)	735 (29.0)
CKO-231	Uncontrolled	05/26/03	16:45	1,829 (6,000)	26 (78)	735 (29.0)
CKO-232	Uncontrolled	05/26/03	17:08	1,829 (6,000)	24 (76)	737 (29.0)
CKO-1022	Uncontrolled	10/12/03	15:35	1,829 (6,000)	24 (76)	734 (28.9)
CKO-1028	Uncontrolled	10/13/03	11:07	1,829 (6,000)	21 (69)	729 (28.7)
CKO-1029	Uncontrolled	10/13/03	11:28	1,829 (6,000)	23 (73)	729 (28.7)
CKO-1030	Uncontrolled	10/13/03	11:49	1,829 (6,000)	23 (74)	729 (28.7)
CKO-1031	Uncontrolled	10/13/03	12:12	1,829 (6,000)	24 (76)	730 (28.8)
CKO-14	EnviroKleen, B	10/13/02	14:36	1,829 (6,000)	19 (66)	752 (29.6)
CKO-15	EnviroKleen, B	10/13/02	15:08	1,829 (6,000)	17 (63)	752 (29.6)
CKO-16	EnviroKleen, B	10/13/02	15:33	1,829 (6,000)	14 (58)	753 (29.6)
CKO-17	EnviroKleen, B	10/13/02	15:57	1,829 (6,000)	14 (57)	753 (29.6)
CKO-18	EnviroKleen, B	10/13/02	16:23	1,829 (6,000)	13 (56)	753 (29.6)
CKO-206	EnviroKleen, B	05/24/03	12:20	1,829 (6,000)	24 (75)	732 (28.8)
CKO-207	EnviroKleen, B	05/24/03	12:53	1,829 (6,000)	24 (76)	729 (28.7)
CKO-208	EnviroKleen, B	05/24/03	13:25	1,829 (6,000)	25 (77)	729 (28.7)
CKO-209	EnviroKleen, B	05/24/03	14:09	1,829 (6,000)	27 (80)	729 (28.7)
CKO-210	EnviroKleen, B	05/24/03	14:41	1,829 (6,000)	27 (80)	732 (28.8)
CKO-1023	EnviroKleen, B	10/12/03	16:28	1,829 (6,000)	26 (78)	734 (28.9)

(continued)

Table 13. (continued)

Run	Test section	Date	Test start time	Total distance, m (ft)	Temperature, °C (°F)	Barometric pressure, mm Hg (in. Hg)
CKO-1024	EnviroKleen, B	10/12/03	16:52	1,829 (6,000)	24 (76)	733 (28.8)
CKO-1025	EnviroKleen, B	10/12/03	17:15	1,829 (6,000)	24 (76)	733 (28.8)
CKO-1026	EnviroKleen, B	10/12/03	17:38	1,829 (6,000)	22 (71)	732 (28.8)
CKO-1027	EnviroKleen, B	10/12/03	18:01	1,829 (6,000)	19 (66)	732 (28.8)
MC						
CKO-111	Uncontrolled	05/13/03	17:05	3,658 (12,000)	34 (94)	734 (28.9)
CKO-112	Uncontrolled	05/13/03	17:40	3,658 (12,000)	33 (92)	734 (28.9)
CKO-131	Uncontrolled	05/15/03	8:32	3,658 (12,000)	24 (76)	734 (28.9)
CKO-132	Uncontrolled	05/15/03	9:04	3,658 (12,000)	24 (76)	734 (28.9)
CKO-133	Uncontrolled	05/15/03	9:42	3,658 (12,000)	26 (79)	734 (28.9)
CKO-406	Uncontrolled	08/06/03	11:42	1,829 (6,000)	41 (106)	737 (29.0)
CKO-407	Uncontrolled	08/06/03	12:53	1,829 (6,000)	43 (110)	735 (29.0)
CKO-413	Uncontrolled	08/07/03	8:30	1,829 (6,000)	34 (93)	735 (29.0)
CKO-414	Uncontrolled	08/07/03	8:52	1,829 (6,000)	35 (95)	737 (29.0)
CKO-415	Uncontrolled	08/07/03	9:11	1,829 (6,000)	35 (95)	734 (28.9)
CKO-121	EnviroKleen, B	05/14/03	8:55	3,658 (12,000)	24 (76)	730 (28.8)
CKO-127	EnviroKleen, B	05/14/03	13:49	3,658 (12,000)	37 (98)	734 (28.9)
CKO-128	EnviroKleen, B	05/14/03	14:15	3,658 (12,000)	37 (98)	734 (28.9)
CKO-129	EnviroKleen, B	05/14/03	14:49	3,658 (12,000)	37 (99)	732 (28.8)
CKO-130	EnviroKleen, B	05/14/03	15:14	3,658 (12,000)	36 (96)	730 (28.8)
CKO-408	EnviroKleen, B	08/06/03	13:31	1,829 (6,000)	44 (112)	735 (29.0)
CKO-409	EnviroKleen, B	08/06/03	13:50	1,829 (6,000)	43 (110)	734 (28.9)
CKO-410	EnviroKleen, B	08/06/03	14:14	1,829 (6,000)	46 (115)	737 (29.0)
CKO-411	EnviroKleen, B	08/06/03	14:35	1,829 (6,000)	47 (116)	735 (29.0)
CKO-412	EnviroKleen, B	08/06/03	14:56	1,829 (6,000)	46 (115)	737 (29.0)

Road surface samples were collected on a section each day that section was tested. The surface samples were analyzed for moisture and silt (i.e., fraction passing 200 mesh upon dry sieving). Table 14 presents the moisture content and silt content results for both FLW and MC. With the exception of test periods when unexpected road maintenance occurred (i.e., October 2002 at FLW and August 2003 at MC), the silt content of the treated road surface tends to be less than that for the untreated road section.

Table 14. Road Surface Properties

Test Section	Date	Moisture Content, %	Silt Content, %
FLW			
Uncontrolled	10/12/02[a]	0.4	1.6
	10/13/02[a]	0.63	1.5
	10/14/02[a]	0.75	1.7
	5/24/03	1.8	4.3
	5/26/03	0.01	1.6
	10/12/03	1.4	3.0
	10/13/03	1.5	5.4
	10/13/03	0.62	1.7
EnviroKleen	10/13/02[a]	0.99	3.5
	10/13/02[a]	0.97	5.5
	5/24/03	1.3	1.3
	10/12/03	0.58	1.1
	10/12/03	0.48	4.3
MC			
Uncontrolled	5/14/03	0.22	4.7
	8/6/03[b]	0.32	8.8
	8/6/03[b]	0.32	9.2
EnviroKleen	5/14/03	0.14	1.0
	8/6/03[b]	0.31	3.5

[a] Unexpected road maintenance activity occurred at FLW in September 2002 prior to the October 2002 test period.

[b] Unexpected road maintenance activity appeared to have occurred at MC after the time of the May 2003 visit and prior to the August 2003 test period.

4.0 References

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Appendix A

Environmental Testing

A copy of ABC Laboratories' summary report for aquatic toxicity testing on five dust suppression products[13] is retained in the RTI International project files. The results for EnviroKleen are summarized below.

Solution Preparation

Solutions were prepared on a weight-to-volume basis for all compounds. Liquid sample EnviroKleen was not water soluble and was conducted as the water accommodated fraction (WAF). The Liquid sample EnviroKleen was weighed out into 20 ml glass vials and mixed directly into beakers to stir overnight.

Test Design

Where preliminary testing indicated no mortality at concentrations of 1,000 milligrams per liter (mg/L), abbreviated or limit studies were performed. Acute studies run as limit tests were conducted with a control and a single concentration at 1,000 mg/L. Chronic studies were conducted with a control and three test levels: 250, 500, and 1,000 mg/L. All other studies were conducted with five, or six test levels and a control.

Statistical Analysis

Statistical analysis of the concentration versus effect data was performed using a custom computer program, ToxCalc. This program is designed to calculate the lethal concentration, 50 percent (LC_{50}) / effective concentration, 50 percent (EC_{50}) statistic and its 95 percent confidence interval (CI), as applicable, using the appropriate EPA recommended analysis. Statistical significance of comparison of means for *Ceriodaphnia dubia*, fathead minnow, and *Americamysis bahia* survival and reproduction, growth, and fecundity was determined by hypothesis testing using either Fisher's Exact test or Dunnett's test. Point estimates testing to calculate the LC_{50} or EC_{50} was determined with the Trimmed Spearman-Karber method.

Generally, the statistical approach was as follows: Analysis of each endpoint between samples was evaluated by first analyzing the data for normality and homogeneity of variances with Shapiro-Wilk's Test and Kolmogorov D's Test before comparison of means. If the data were normally distributed and the variances were homogeneous, then analysis of variances (ANOVA) was used for the weight data, along with Fisher's Exact Test or Dunnett's procedure for comparing the means. Survival data were analyzed using Fisher's Exact test, and growth or reproduction data were analyzed using Dunnett's. If the assumptions of normality or homogeneity of variance were not met, transformations of the survival data were employed to allow the use of parametric procedures. If transformations (e.g., arc sine-square root transformation) of the survival data still did not meet assumptions of normality and homogeneity, then the nonparametric test, Steel's Many-One Rank Test, was used to analyze these data.

47551 *Ceriodaphnia dubia* Acute Tests (August 20–22, 2002)

This test was conducted as a limit test with levels of control and 1,000 mg/L. Mortality was 0 percent in both the control and the 1,000 mg/L concentration. The 48-hour LC_{50} for survival was greater than (>) 1,000 mg/L. The no observed effect concentration (NOEC) was 1,000 mg/L and the lowest observed effective concentration (LOEC) was >1,000 mg/L.

47552 Fathead Minnow Acute Tests (August 14–21, 2002)

This test was conducted as a multi-concentration test with levels of control, 62.5, 125, 250, 500, and 1,000 mg/L. Mortality was 0 percent in the control and all test concentrations. The 96-hour LC_{50} for survival was >1,000 mg/L. The NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L.

47553 *Americamysis bahia* Acute Tests (August 22–26, 2002)

This test was conducted as a limit test with levels of control and 1,000 mg/L. Mortality was 0 percent in both the control and the 1,000 mg/L concentration. The 96-hour LC_{50} for survival was >1,000 mg/L. The NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L.

47554 *Ceriodaphnia dubia* Chronic Tests (August 21–28, 2002)

This test was conducted as a multi-concentration test with levels of control, 250, 500, and 1,000 mg/L. Mortality was 0 percent in the control and 0, 10, and 10 in the 250, 500, and 1000 mg/L test levels, respectively. The 7-day LC_{50} for survival was >1,000 mg/L. For survival, the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L. The 7-day EC_{50} for reproduction was >1,000 mg/L. For reproduction, the NOEC was 1,000 mg/L and LOEC was >1,000 mg/L.

47555 Fathead Minnow Chronic Tests (August 14–21, 2002)

This test was conducted as a multi-concentration test with levels of control, 62.5, 125, 250, 500, and 1,000 mg/L. Mortality was 3 percent in the control. Mortality was 10, 10, 3, 3, and 3 percent in the 62.5, 125, 250, 500, and 1,000 mg/L test levels, respectively. The 7-day LC_{50} for survival was >1,000 mg/L. For survival, the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L. The 7-day EC_{50} for growth was >1,000 mg/L. For growth, the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L.

47556 *Americamysis bahia* Chronic Tests (August 29– September 5, 2002)

This test was conducted as a multi-concentration test with levels of control, 250, 500, and 1,000 mg/L. Mortality was 15 percent in the control. Mortality was 15, 8, and 5 percent in the 250, 500, and 1,000 mg/L test levels, respectively. The 7-day LC_{50} for survival was >1,000 mg/L. For survival, the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L. The 7-day EC_{50} for growth was >1,000 mg/L. For growth, the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L. The 7-day EC_{50} for fecundity was >1,000 mg/L. For fecundity, the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L.

Appendix B

Chemical Testing

Tri-State Laboratories' analysis report of five dust suppression products[14] is retained in the RTI International project files. The results for EnviroKleen are included on the pages that follow.

Enviro-Kleen®
ENVIRONMENTAL DATA

VOC, SEMI-VOLATILES, METALS,TCLP, PAH TESTS

PERFORMED BY: TSL, Tri-State Laboratories

REPORT DATA: July 15, 2002

SUMMARY: As part of the US EPA Environmental Technology Verification (ETV) Program Enviro-Kleen® was tested to determine major, minor and trace constituents using various EPA test methods.

Bulk analysis techniques were used to quantitatively determine the presence of Title 22 metals, Volatile Organic Compounds (VOC), Semi-volatiles, pesticides herbicides and Polynuclear Aromatic Hydrocarbons (PAH) in Enviro-Kleen®. Bulk analysis is performed on the sample in the "as received" form and does not consider application rates, dilution ratios or environmental conditions. The vast majority of the analytes were found to be Below Detection Limits (BDL). Ever evolving sophistication of analytical methods and techniques have made detection limits well below regulatory levels. Some metals were detected at low levels, primarily iron and that can be attributed to the use of carbon steel tanks in transportation and storage.

Toxicity Characteristic Leaching Procedure (TCLP) is a sample preparation and battery of tests that can determine the presence of various elements and chemical compounds in a landfill type situation. In this test Enviro-Kleen® was subjected to chemical extractions to “leach” the analytes from the product. This includes metals, volatiles and semivolatiles analysis. All analytes were determined to be "below detection limits".

RESULTS: Results indicate that Enviro-Kleen® contains no bulk analysis or TCLP elements or compounds above regulatory levels. Most materials were not detected in Enviro-Kleen®. Please see attached for results.

EnviroKleen®
ENVIRONMENTAL DATA

Acute and Chronic Aquatic Toxicity

PERFORMED BY: ABC Laboratories, Inc.

REPORT DATA: September 16, 2002

SUMMARY: As part of the US EPA Environmental Technology Verification (ETV) Program EnviroKleen® (Liquid Sample B) was tested to determine chronic and acute toxicity to aquatic species: Ceriodaphnia dubia, Fathead minnow and Americamysis bahia (Mysid shrimp).

Concentrated EnviroKleen® was evaluated per the following EPA test methods:

*Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, EPA/600/4-90/027F.

*Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, EPA/600/4-91/002.

*Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Marine and Estuarine Organisms, EPA/600/4-91/003.

RESULTS: The results indicate that EnviroKleen® has very low aquatic toxicity levels and is not considered an aquatic pollutant.

Ceriodaphnia dubia Acute, EC_{50}:	>1000mg/L
Fathead minnow Acute, LC_{50}:	>1000mg/L
Americamysis bahia Acute, EC_{50}:	>1000mg/L
Ceriodaphnia dubia Chronic, EC_{50}:	>1000mg/L
Fathead minnow Chronic, LC_{50}:	>1000mg/L
Americamysis bahia Chronic, EC_{50}:	>1000mg/L

STUDY TITLE

7-Day Survival and Growth Tests of Dust Suppression Products EK-35 and EnviroKleen to the Rainbow Trout, *Oncorhynchus mykiss*, Determined Under Static Renewal Conditions

SPONSOR

Midwest Industrial Supply
1101 3rd Street Southeast
Canton, Ohio 44707

AUTHOR

Chris Hughes
Associate Scientist

REPORT COMPLETED ON

September 3, 2003

PERFORMING LABORATORY

ABC Laboratories, Inc.
7200 E. ABC Lane
Columbia, Missouri 65202

PROJECT ID

48341

SIGNATURE PAGE

Submitted by: ABC Laboratories, Inc.
7200 E. ABC Lane
Columbia, Missouri 65202

Prepared by:

_____

Chris Hughes Date
Associate Scientist
ABC Laboratories, Inc.

ACUTE TOXICITY COMPENDIUM

Subject: 7-Day Survival and Growth Tests of Dust Suppression Products EK-35 and EnviroKleen to the Rainbow Trout, *Oncorhynchus mykiss*, Determined Under Static Renewal Conditions

Sponsor: Midwest Industrial Supply
1101 3rd Street Southeast
Canton, Ohio 44707

Test Substances: EK-35 and EnviroKleen

Definitive Test Concentrations: EK-35: 0 (control), 5.0, 10, 20, 40, and 80 mg/L
EnviroKleen: 0 (control), 250, 500, and 1,000 mg/L

Solution Preparation: WAF (Water Accommodated Fraction), Stirred overnight

Definitive Test Dates: August 6 to 13, 2003

Duration of Test: 7 days

Organism Source: In-house cultures

Age at Initiation: 57 days post-hatch

Test Procedures and Conditions:

Temperature:	12 ± 2°C
Lighting:	Ambient laboratory lighting, 16:8-hr light:dark
Observations:	Days 1, 2, 3, 4, 5, 6, and 7
Test chambers:	4-L glass containers
Volume per chamber:	3.0 L
Replicates per treatment:	4
Organisms per chamber:	5
Organisms per treatment:	20
Dilution water:	Blended freshwater
Solution renewal:	Daily
Aeration:	60-100 bubbles/minute

Methods:

U.S. EPA. 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 5th ed. U.S. Environmental Protection Agency, EPA/84/R-02/012.

U.S. EPA. 2002. Short-Term Methods For Estimating The Chronic Toxicity Of Effluents And Receiving Water To Freshwater Organisms, Fourth Edition. EPA/821/R-02/013. 335 p.

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Toxcalc™ Version 5.0, Release 6.12. Copyright 1994 by Tidepool Scientific Software: Michael A. Ives.

Results:

Rainbow Trout 7-Day Static Renewal Test with EK-35 Cumulative Percent Mortality							
Nominal Loading Concentration (mg/L)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	0	0	0	0	0	0	0
5.0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
20	0	0	0	10	10	10	35
40	65	75	80	90	95	95	95
80	100	100	100	100	100	100	100
Note: Five fish per replicate, 20 fish per treatment.							

Rainbow Trout 7-Day Static Renewal Test with EnviroKleen Cumulative Percent Mortality							
Nominal Loading Concentration (mg/L)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0
1,000	0	0	0	0	0	0	0
Note: Five fish per replicate, 20 fish per treatment.							

Rainbow Trout 7-Day Static Renewal Test with EK-35 Mortality and Growth		
Nominal Loading Concentration (mg/L)	Mortality at 7 Days (%)	Mean Weight per Fish (mg)
Control	0	153.5
5.0	0	174.7
10	0	151.5
20	35	110.2
40	95	115.2
80	100	NA

Rainbow Trout 7-Day Static Renewal Test with EnviroKleen Mortality and Growth		
Nominal Loading Concentration (mg/L)	Mortality at 7 Days (%)	Mean Weight per Fish (mg)
Control	0	140.0
250	0	149.9
500	0	152.9
1,000	0	155.2

Rainbow Trout 7-Day Static Renewal Test with EK-35 Water Quality Ranges			
Solution ID	Temperature (ºC)	Dissolved Oxygen as mg/L (% Saturation)	pH
New Solutions	12.4 – 13.0	8.5 – 9.9 (84 – 98)	8.2 – 8.6
Old Solutions	11.7 – 12.9	3.6 – 11.5 (35 – 112)	7.5 – 8.5

Notes: Beginning at Day 1, gentle aeration was provided on all new solutions after renewals at a rate of 60-100 bubbles/minute. After aeration was provided, dissolved oxygen remained ≥4.0 mg/L (40% saturation) for the remainder of the study.

100% saturation at 12 and 13°C corrected for local altitude and mean barometric pressure is 10.3 and 10.1 mg/L, respectively.

Rainbow Trout 7-Day Static Renewal Test with EnviroKleen Water Quality Ranges			
Solution ID	Temperature (ºC)	Dissolved Oxygen as mg/L (% Saturation)	pH
New Solutions	12.3 – 13.2	8.4 – 10.1 (83 – 100)	8.2 – 8.5
Old Solutions	11.7 – 12.7	3.3 – 10.8 (32 – 105)	7.6 – 8.3

Notes: Beginning at Day 1, gentle aeration was provided on all new solutions after renewals at a rate of 60-100 bubbles/minute. After aeration was provided, dissolved oxygen remained ≥6.9 mg/L (67% saturation) for the remainder of the study.

100% saturation at 12 and 13°C corrected for local altitude and mean barometric pressure is 10.3 and 10.1 mg/L, respectively.

Statistical Analysis:

Rainbow Trout 7-Day Static Renewal Test Statistical Analysis (mg/L)						
Sample ID	7-Day Survival			7-Day Growth		
	LC_{50} (95% CI)	NOEC	LOEC	EC_{50} (95% CI)	NOEC	LOEC
EK-35	23 (19 – 27)	10	20	>10	10	>10
EnviroKleen	>1,000	1,000	>1,000	>1,000	1,000	>1,000

Discussion:

Solution Preparation:

Solutions were prepared on a weight to volume basis for both compounds. EK-35 and EnviroKleen were not water-soluble and were conducted as the water accommodated fraction (WAF). EK-35 was weighed out on glass microscope slides and added to the preparation jars of water. The jars were placed on a stir plate and stirred overnight. Solutions were drawn off by siphoning the solutions into replicate test chambers. This undissolved test compound was not included in solutions for two reasons. One, so that it would not cause a decrease in dissolved oxygen transfer by covering the surface of the test vessels, and two, so that it would not cause secondary toxicity from impairment of the test fish respiratory system in the case of the rainbow trout gills. The EnviroKleen sample was weighed out into 20-mL glass vials and mixed directly into the WAF preparation jars to stir overnight.

Test Design:

A 72-hour static range-finding study was conducted at nominal loading concentrations of 0 (control), 10, 100, and 1,000 mg/L. Mortality was 0, 0, 100, and 100% in the EK-35 concentrations of 0 (control), 10, 100, and 1,000 mg/L, respectively. No mortality was observed in the any of the EnviroKleen concentrations. Based upon the results of the range-finding test, the definitive tests were conducted at nominal loading concentrations of 0 (control), 5.0, 10, 20, 40, and 80 mg/L for EK-35, and as an abbreviated definitive for EnviroKleen with nominal loading concentrations of 0 (control), 250, 500, and 1,000 mg/L.

Statistical Analysis:

Statistical analysis of the concentration versus effect data was performed using a custom computer program, ToxCalc. This program is designed to calculate the LC_{50}/EC_{50} statistic and its 95% confidence interval (CI), where possible, using the appropriate EPA recommended analysis. Statistical significance of comparison of means for Rainbow Trout survival and growth was determined by hypothesis testing using EPA recommended methods, typically either Fisher's Exact test or Dunnett's test. Point estimates testing to calculate the LC_{50} or EC_{50} was determined with the Trimmed Spearman-Karber method where possible.

Generally, the statistical approach was as follows. Analysis of each endpoint between samples was evaluated by first analyzing the data for normality and homogeneity of variance with Shapiro-Wilk's Test and Kolmogorov D's Test before comparison of means. If the data were normally distributed and the variances were homogeneous, then analysis of variance (ANOVA) was utilized for the weight data along with Fisher's Exact Test or Dunnett's procedure for comparing the means. Survival data were analyzed using Fisher's Exact test and growth was analyzed using Dunnett's. If the assumptions of normality or homogeneity of variance were not met, transformations of the survival data were employed to allow the use of parametric procedures. If transformations (e.g., arcsine-square root transformation) of the survival data still did not meet assumptions of

normality and homogeneity, then the non-parametric test, Steel's Many-One Rank Test, was used to analyze these data.

Biological Results:

EK-35:

This study was conducted as a multi-concentration test with levels of 0 (control), 5.0, 10, 20, 40, and 80 mg/L. Mortality was 0% in the control. After seven days, mortality was 0, 0, 35, 95, and 100% in the 5.0, 10, 20, 40, and 80 mg/L, respectively. The 7-day LC_{50} for survival was 23 mg/L with 95% confidence intervals of 20 to 27 mg/L. For survival the no-observed effect concentration, or NOEC was 10 mg/L and the lowest observed effective concentration, or LOEC, was 20 mg/L. The 7-day EC_{50} for growth was 23 mg/L with 95% confidence intervals of 19 to 27 mg/L. For growth, the NOEC was 10 mg/L and the LOEC was >10 mg/L.

EnviroKleen:

This study was conducted as an abbreviated test with levels of 0 (control), 250, 500, and 1,000 mg/L. After seven days, no mortality was observed in any control or test substance treatment. The 7-day LC_{50} for survival was >1,000 mg/L and a 95% confidence intervals could not be calculated. For survival the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L. The 7-day LC_{50} for growth was >1,000 mg/L and the 95% confidence intervals could not be calculated. For growth the NOEC was 1,000 mg/L and the LOEC was >1,000 mg/L.