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July 21, 2008 Peer-Review Version

Evaluation of the Alternative Asbestos Control Method at Site Three (AACM3) for Demolition of Asbestos-Containing Buildings

By

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July 21, 2008

Contract No. EP-C-05-058
Task Order No. 0057

FOREWORD

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Sally Gutierrez, Director
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Table of Contents

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Asbestos NESHAP (National Emission Standards for Hazardous Air Pollutants) generally requires the removal of all Regulated Asbestos-Containing Material (RACM) from a building prior to its demolition. In many circumstances, this removal process can be a costly and time-consuming endeavor and is believed to contribute to the growing crises of abandoned buildings in this country. Under this Alternative Asbestos Control Method (AACM) research project, certain asbestos-containing materials (ACM) were allowed to remain in the building during demolition. In addition to leaving most of the ACM in the building, the AACM process differed from the NESHAP process in that the interior of the building was pre-wetted with amended water (water with a wetting agent added), all demolition and debris-loading activities were continuously wetted with amended water, all runoff was contained, three or more inches of soil were removed after demolition, all materials were disposed of as RACM, and respirators and protective garments were worn by workers throughout the entire demolition process.

This research project (AACM3) is the third of the AACM research efforts, each targeting specific asbestos and building/site configurations. AACM3 evaluated the use of the AACM demolition process on a building which contained significant amounts of asbestos-containing popcorn ceilings and troweled-on surfacing materials.. Separate reports have been issued for AACM1 and AACM2.

At this time, the AACM is a research method only and EPA does not permit its use as an approved work practice under the Asbestos NESHAP for demolishing buildings containing RACM.

Conclusions

The following conclusions are relevant to the demolition of the popcorn building (AACM3) in Fort Worth:

Primary Objective:

- The airborne asbestos concentrations measured in the perimeter ring by transmission electron microscopy (TEM) during the AACM3 demolition process were orders of magnitude below any EPA existing health or performance criterion. At an analytical sensitivity of 0.0005 asbestos structures per cubic centimeter of air (s/cm^3) and corresponding detection limit of 0.0015 s/cm^3, the maximum asbestos air concentration was 0.0030 s/cm^3 (six structures observed) in the perimeter monitoring ring for the AACM3 process during demolition of a building with popcorn ceilings and troweled-on surfacing material that contained regulated amounts of asbestos.

- Most of the airborne asbestos (TEM) concentrations were near or below the limit of detection, which was 0.0015 s/cm^3. Due to this limitation, the Peto-Prentice test for censored data (non-detects) was conducted. Based on the results of this inferential test (*p*-value = 0.29), one would ***fail to reject*** the null hypotheses of no difference in the perimeter airborne asbestos distributions for AACM3 versus background; therefore one cannot conclude the AACM3 and background airborne asbestos concentrations observed during the entire process are different (where *p* represents a strength of evidence that the null hypothesis is true). The smaller the p-value, the stronger the evidence is that the null hypothesis should be rejected. In this study, the null hypothesis was rejected for *p* values less than 0.05.

Secondary Objectives

- No visible emissions were observed by EPA staff during the AACM3 demolition process.

- The fiber concentrations in air from the AACM3 demolition process as measured by phase contrast microscopy (PCM) were not judged to be different from the background fiber concentrations. The statistical analysis (*t*-test for mean differences) indicated that *one would* ***fail to reject*** *the null hypothesis of no difference in the mean concentration of total fibers observed for AACM3 and background… (p=0.97).*

- There was no statistically significant difference in the settled dust asbestos concentrations comparing the background with the perimeter when the entire process (pre-wetting through cleanup) was evaluated because of a high value with no assignable cause that was observed in one of the background samples. The statistical analysis indicated since *… the results from the inferential tests at the 0.05 level of significance are inconclusive, no inferences can be made regarding the asbestos concentrations in the settled dust of the AACM and background data ...*; however, based upon the descriptive statistics, there does appear to be an increase in settled dust asbestos concentrations as a result of the demolition activity.

- In seventeen worker samples taken over the course of the AACM3 demolition process of the popcorn building, only one sample had detectable asbestos and even then only a single asbestos structure was observed. The extremely low worker breathing zone asbestos concentrations seen in AACM3 appear to offer a significant advantage for the AACM. The Time-Weighted Averages (TWA) were very low (0.002 f/cm^3 max), which is far below the OSHA Permissible Exposure Limit (PEL) of 0.1 f/cm^3 that is based upon PCM analysis.

- The asbestos concentration in the soil after the AACM3 demolition process appeared equal to the background soil asbestos concentration, but there were too many censored data (non-detects) to conduct a meaningful statistical analysis (53-percent non-detects for the background vs. 80-percent non-detects for the post-excavation soil asbestos concentrations). Statistically, the asbestos concentrations in the post-demolition soil were not judged different than the asbestos concentrations in the pre-demolition soils using the Peto-Prentice test for censored data (p value=0.67); however, based upon descriptive statistics, they appear so. Based on this test one would ***fail to reject*** the null hypothesis of no difference in the asbestos concentration in pre-demolition and post-demolition soils.

- The asbestos concentrations in the pavement surface samples after the AACM3 process were judged equal to the asbestos concentrations in the background pavement surface samples. All background, pre-demolition, and post-demolition pavement samples were non-detect for asbestos at a <1000 s/cm^2 analytical sensitivity. Since all asbestos concentrations in the pavement surface samples after the AACM3 process were below the analytical sensitivity, no inferential test could be conducted. Based on the empirical data, there is no evidence to suggest the asbestos concentrations on the pre-demolition versus post-demolition pavement and on the pre-demolition versus background pavement are different.

- The concrete slab, which was later removed, had asbestos detected in four of six surface samples.

- No water was released from the AACM3 site. Of the 9500 gallons of amended water added, none required filtration or disposal to the sewer as virtually all either left with the demolition debris or percolated into the soil and was removed with the excavation waste. Water samples taken from pooled sites during the demolition contained asbestos, with a maximum concentration near 100 million structures per liter, thereby justifying the need for soil removal if the water reaches the soil.

- The time required to perform the AACM3 demolition process (3½ days) was about half the time that was estimated to perform the NESHAP (abatement plus demolition) process (six days) for this site. The AACM3 demolition process took far longer than expected because of many administrative delays, disruptions caused by other parties, and a learning curve on the AACM3 technology on the part of the contractor that had to be acquired at the last minute.

- The total cost of the AACM3 demolition process was about \$35,400 or about \$16.50/ft^2 of building footprint or \$4.48/ft^2 of surfacing material. This cost is estimated to be about 20-percent higher than would have been required, due to many organizational delays that were encountered; part of which were due to the research nature of the effort. The total cost for a NESHAP demolition (abatement plus demolition) of the popcorn building was estimated to be about \$31,600 or \$14.70 /ft^2 of building footprint or \$4.00/ft^2 of surfacing material.

ACKNOWLEDGMENT

This was truly a multi-faceted team effort bridging not only the asbestos expertise within EPA and the Environmental Management Department of the City of Fort Worth, but also the highest caliber contractual support to accomplish the objectives of this study. Each individual listed made significant contributions, either past or current, that contributed to the success of the project. The onsite support received from the individuals in the City of Fort Worth organizations was exemplary. Their cordiality, hospitality, helpfulness, and willing assistance were essential components for the execution and completion of the research project.

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City of Fort Worth: Mayor Mike Moncrief, Councilman Danny Scarth, Brian Boerner , Michael Gange, Roger Grantham, Derek Senter, Susie Sweeton, Larinda Smith, Kevin Pas, Pamela Green, Angela Rush , Christa Lopez, Jeanine Ricks, Daniel Reimer, Cecilia Jacobs, and Libby Watson.

U.S. Occupational Safety and Health Administration: Mike Talmont, Dean Wingo, and Dean McDaniel, Dallas, TX.

U.S. EPA Senior Management: Richard Greene, George Gray, Larry Starfield, Kevin Teichman, Sally Gutierrez, Louise Wise, Carl Edlund, and Myron Knudson.

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ABBREVIATIONS AND ACRONYMS

AACM	Alternative Asbestos Control Method
ACM	Asbestos-Containing Material
ADEQ	Arkansas Department of Environmental Quality
AED	Aerodynamic Equivalent Diameter
AHERA	Asbestos Hazard and Emergency Response Act
AQMD	Air Quality Management District
ASTM	American Society for Testing and Materials
C&D	Construction and Demolition
CDF	Cumulative Distribution Function
DL	Detection Limit
DMF	Dimethylformamide
DOE	US Department of Energy
EPA	US Environmental Protection Agency
GPM	Gallons per Minute
GR	Gravimetric Reduction
GRR	Gravimetric Reduction Ratio
HEPA	High Efficiency Particulate Air
ISO	International Standards Organization
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectroscopy
K-S Test	Komolgorov-Smirnov Test
MCE	Mixed Cellulose Ester Filter
MDL	Method Detection Limit
MFL	Millions of Fibers Per Liter
NAA	No Action Assurance
NEA	No Enforcement Assurance
NEIC	USEPA National Enforcement Investigations Center
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	US National Institute of Occupational Safety and Health
NRMRL	USEPA National Risk Management Research Laboratory
OAQPS	USEPA Office of Air Quality Planning and Standards
OECA	USEPA Office of Enforcement and Compliance Assurance
OGC	USEPA Office of General Counsel
OIG	USEPA Office of the Inspector General
OPEI	USEPA Office of Policy, Economics, and Innovation
OPPT	USEPA Office of Pollution Prevention and Toxics
ORD	USEPA Office of Research and Development
OSHA	US Occupational Safety and Health Administration
OSRTI	USEPA Office of Superfund Remediation and Technology Innovation
OSW	USEPA Office of Solid Waste
PCM	Phase Contrast Microscopy

PCME	Phase Contrast Microscope Equivalent
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
PEL	Personal Exposure Limit
PLM	Polarized Light Microscopy
PSI	Pounds per Square Inch
QAPP	Quality Assurance Project Plan
RACM	Regulated Asbestos-Containing Material
RCRA	Resource Conservation and Recovery Act
T&D	Transportation and Disposal
TEM	Transmission Electron Microscopy
TDSHS	Texas Department of State Health Services
TSA	Technical Systems Audit
TSI	Thermal System Insulation
TWA	Time-Weighted Average
VAC	Volts Alternating Current
VAT	Vinyl Asbestos Tile
WTC	World Trade Center

SECTION 1 INTRODUCTION

1.1 Background

The Clean Air Act provides the EPA with the authority to promulgate a "*work practice standard*" if it is not feasible to establish an emission standard to control the emissions of hazardous air pollutants. Under Section 112(b) of the Clean Air Act, asbestos is identified as a hazardous air pollutant and is regulated under EPA's National Emission Standard for Asbestos (Asbestos NESHAP), 40 CFR Part 61, Subpart M.

The AACM research protocol differs from the NESHAP in that it requires that certain RACM (such as thermal system insulation and fireproofing) be removed before demolition in accordance with the Asbestos NESHAP; other RACM (such as popcorn ceilings, troweled-on surfacing, transite, wallboard joint compound, resilient flooring/mastic, glazing compound) may remain in place. Further, the AACM varies from the existing Asbestos NESHAP in the use of an amended-water wetting process, type of demolition equipment used, and demolition techniques. Once the required RACM is removed, the demolition proceeds using amended water suppression before, during, and after demolition to trap asbestos fibers and minimize the potential release of such fibers to the air. Wastewater generated during the demolition is collected and filtered, and all debris is disposed of as RACM. Soil in the affected area is excavated and disposed as RACM.

The Asbestos NESHAP (*a work practice standard*) generally requires the removal of all regulated asbestos-containing material (RACM)[1] prior to demolition of a covered facility. The Asbestos NESHAP specifies emission control procedures [§61.145(c)] and waste disposal requirements [§61.150] that must be followed during demolition of a facility that contains RACM above the threshold amount.[2] In addition, Section §61.150 of the Asbestos NESHAP requires owners or operators to "discharge no visible emissions to the outside air" during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated during the demolition activity. If a facility is being demolished because it is structurally unsound and is in danger of imminent collapse, RACM is not removed prior to demolition, but the RACM must be kept adequately wet during demolition

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1 Under the Asbestos NESHAP, RACM means (a) friable asbestos material, (b) Category I nonfriable ACM that has become friable, (c) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading, or (d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations regulated by this subpart. (40 CFR 61.141).

2 The Asbestos NESHAP [§61.145(a)] requires that if the following amounts of RACM are present in a facility, these materials must be removed prior to demolition: (1) At least 260 linear feet on pipes; or (2) at least 160 square feet on other facility components; or (3) where the amount of RACM on pipes or other components could not be measured before stripping, a total of at least 35 cubic feet from all facility components in a facility being demolished. Also, under 40 CFR 61.145 (c), ACM has to be removed if: (1) it is Category I nonfriable ACM that is in poor condition and is friable or (2) it is Category II nonfriable ACM and the probability is low that the materials will become crumbled, pulverized, or reduced to powder during demolition. (These regulations may be supplanted by more stringent local governmental [state, city, etc.] regulations that govern such activities).

and all of the contaminated debris, including the RACM, must be kept adequately wet until disposal and must be disposed of as RACM.

The purpose of this research project is to gather additional data to document the environmental and cost-effectiveness of the AACM. In evaluating the AACM, the EPA first performed a side-by-side comparison of the AACM and the NESHAP on identical buildings at Fort Chaffee Redevelopment Authority (Wilmoth et al, 2007). This is known as AACM1. The buildings in the first study (AACM1) had positive asbestos –containing wall systems that were RACM and vinyl asbestos floor tile. The EPA then performed a follow-up study (AACM2), which evaluated the environmental impacts of using the AACM to demolish a building that contained asbestos (RACM) in the form of transite siding. This third study (AACM3) evaluated the environmental impacts of using the AACM to demolish a building that contained asbestos (RACM) in the form of popcorn ceilings and troweled-on wall coatings. The data from AACM3 will be used in conjunction with data obtained during AACM1 and AACM2 to help EPA determine whether it is appropriate to propose including an alternate method along the lines of the AACM in the current Asbestos NESHAP regulations.

1.2 Objective

The goal of this research study was to collect data on the environmental effectiveness and cost of the AACM for demolition of buildings that contain popcorn ceilings and troweled-on surface coatings. The AACM will be considered for modification to the Asbestos NESHAP as an additional tool to safely demolish asbestos-containing structures. All of the data collected during this follow-up study will be evaluated and considered, as appropriate.

SECTION 2 DRAFT ALTERNATIVE ASBESTOS CONTROL METHOD (AACM)

Developed by EPA Region 6 and EPA Office of Research and Development
November 1, 2007 version

2.1 Background

In response to Section 112 of the Clean Air Act which requires EPA to develop emission standards for hazardous air pollutants, EPA has promulgated several National Emissions Standards for Hazardous Air Pollutants (NESHAP). 40 CFR Part 61 Subpart M contains the Asbestos NESHAP which specifically addresses, among other things, demolition activities

Asbestos NESHAP regulations generally require that all regulated asbestos-containing materials (RACM) be removed from covered facilities prior to demolition if the RACM exceeds a specified amount. Asbestos-containing materials (ACM) are defined as those materials containing more than one percent asbestos as determined using the method specified in Appendix E, Subpart E, 40 CFR Part 763, Section 1, Polarized Light Microscopy (PLM). RACM includes friable ACM; Category I non-friable ACM that has become friable, Category I non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading; and Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected during demolition operations.

In some circumstances, asbestos removal can account for a significant portion of the total demolition costs. In many cities, the cost of asbestos removal prohibits timely demolitions and results in substandard structures which become fire and safety hazards, attract criminal activity, and lower property values.

For structures that are structurally unsound and in danger of imminent collapse, the Asbestos NESHAP requires that the portion of the structure which contains RACM must be kept adequately wet during demolition and during handling and loading of debris for transport to a disposal site. No other engineering controls are required.

This Alternative Asbestos Control Method (AACM) research protocol was developed by EPA as a potential alternative work practice to the Asbestos NESHAP, where certain RACM are removed prior to demolition and other RACM are left in place.

The goal is to provide significant cost savings while achieving equal protection of human health and the environment. This method is much more restrictive than the Asbestos NESHAP requirements for buildings in danger of imminent collapse.

2.2 Applicability

As defined, this Alternative Asbestos Control Method research protocol could be applicable to any facility subject to the Asbestos NESHAP regulation (i.e., structures that meet the definition of facility under the Asbestos NESHAP), except as noted below. However, the size of structures which can be demolished using this method is limited to three stories or less (maximum height of

35 feet). This allows adequate wetting of both the interior and exterior of the structures and is within the working reach of both the wetting and the demolition equipment.

2.3 Building Inspection/ Asbestos Assessment

A comprehensive inspection of the interior and exterior of the structure to be demolished shall be conducted in accordance with EPA's Asbestos Hazard Emergency Response Act (AHERA, 40 CFR Part 763). Specific criteria for inspection, sampling, and assessment are in Subpart E (763.85, 763.86, and 763.88, respectively). An acceptable alternative protocol is the American Society of Testing and Materials (ASTM) E2356-04e1 Standard Practice for Comprehensive Building Asbestos Surveys. The inspection shall be performed by an accredited asbestos building inspector.

2.4 Asbestos Removal

Table 2-1 summarizes the ACM that may be present in buildings and whether or not the ACM must be removed prior to demolition.

All thermal system insulation (TSI) and spray-applied fireproofing shall be removed due to the inability to adequately wet these materials during demolition. Fire curtains may be removed if it is easier to do so than to adequately wet and handle this heavy material.

Vermiculite insulation, if present, shall be removed prior to demolition as an RACM, regardless of the measured asbestos concentration.

All asbestos removal operations shall be performed in accordance with state and federal law by a licensed asbestos abatement contractor.

2.5 Demolition Practices

Several demolition work practice standards shall be employed to ensure that the method is protective of human health and the environment. These standards involve the equipment used, the wetting process, the demolition process, and visible emissions.

Demolition contractors shall provide an Asbestos NESHAP-trained individual to oversee the demolition process.

2.5.1 Equipment Used

Track hoes and end loaders or equivalent shall be used during demolition to minimize the generation of dust. No bulldozers, explosives, or burning will be permitted.

Table 2-1. ASBESTOS REMOVAL REQUIREMENTS OF AACM

Asbestos-Containing Material	Removed Prior to Demolition?
Thermal System Insulation (TSI)	
▪ Tank insulation	Yes
▪ Pipe insulation	Yes
▪ Elbow/fitting/valve insulation	Yes
▪ Boiler insulation	Yes
▪ Duct insulation	Yes
▪ Cement and patching compound	Yes
Surfacing Material	
▪ Asbestos-impregnated plaster, stucco	No
▪ Spray-applied fireproofing	Yes
▪ Spray-applied surface coatings (popcorn ceiling, vermiculite treatments)	No
▪ Spray applied acoustical or decorative surfacing	No
▪ Troweled-on crows foot texture, splatter texture, and joint compound.	No
▪ Spray-applied surface coatings crow's foot texture, splatter texture, etc.	No
Miscellaneous Material	
▪ Mastic for flooring	No
▪ Window Caulking	No
▪ Fire curtains in auditoriums	Optional
▪ Fire doors	Optional
▪ Vibration-dampening cloths	No
▪ Asbestos-cement tiles, sheets, roofing, shingles, and transite	No
▪ Asbestos-impregnated roofing cement and asphalt roofing	No
▪ Shingles	No
▪ Linoleum or other floor tile	No
▪ Roll flooring	No
▪ Ceiling tile	No
▪ Asbestos-impregnated pipe	No
▪ Vermiculite insulation	Yes

2.6 Wetting Processes

Structures to be demolished will be thoroughly and adequately wetted with amended water (water to which a surfactant has been added) prior to demolition, during demolition, and during debris handling and loading. Surfactants reduce the surface tension of the water, increasing its ability to penetrate the ACM.

For this method, the Asbestos NESHAP definition for "adequately wet" will be used. That is, "sufficiently mix or penetrate with liquid to prevent the release of particulates. If visible emissions are observed coming from the ACM, then that material has not been adequately wetted. However, the absence of visible emission is not sufficient evidence of being adequately wet." The demolition contractor's Asbestos NESHAP-trained individual will verify that ACM is adequately wetted.

Amended water shall be applied with a minimum of two fire hoses. The amended water shall be delivered as a mist. Direct high-pressure water impact of RACM is prohibited. There must be visible foam forming at the impact of the spray and the structure.

The wetting process consists of three stages. In each stage, both interior and exterior wetting of the structure shall be performed. To the extent feasible, cavity areas and interstitial wall spaces shall be wetted during each of the wetting stages.

On the day before the demolition, access openings shall be made into the attic spaces from the exterior. The structure shall be first pre-wet (until adequately wet) from the interior and then from the constructed exterior attic access openings to enhance water retention and maximize wetting effectiveness.

This pre-wetting shall prohibit further access into the structure, because of safety concerns. The structure shall be re-wet (until adequately wet) from the exterior through the windows, doors, and attic access openings on the day of demolition prior to demolition. Finally, wetting (until adequately wet) shall be done during the demolition and during loading of debris into lined disposal containers.

2.7 Demolition Process

The demolition contractor shall minimize breakage of asbestos-containing materials. All demolition shall be completed in a timely manner that will allow the debris generated during that day to be completely removed from the demolition site for disposal.

2.8 Visible Emissions

The Asbestos NESHAP standard of "no visible emissions" shall be employed. Visible emissions mean any emissions, which are visually detectable without the aid of instruments, coming from RACM or asbestos-containing material. This does not include condensed, uncombined water vapor. The demolition contractor's NESHAP-trained individual shall verify the absence of visible emissions and has the authority to stop work if visible emissions are observed.

During a demolition, it is often not possible to distinguish visible emissions from ACM and those from construction debris; therefore, should a visible emission be observed, the demolition effort shall pause until the deficiencies in the application of the wetting controls eliminate the visible emission.

2.9 Weather Restrictions

Demolition activities shall be delayed/halted in the case of any inclement weather that will impede the demolition contractor's ability to adequately wet the structure (e.g., freezing temperatures).

In addition, if visible dusting is observed in the vicinity of the demolition site, the demolition shall be delayed/halted.

2.10 Monitoring Requirements

Demolition contractors are required to comply with all applicable OSHA (29 CFR 1926) regulations for worker protection during asbestos removal and demolition activities. This includes the use of personal protective equipment (PPE) such as Tyvek suits or equivalent, respirators (as necessary), and gloves (as necessary); and personal monitoring.

Because, like the Asbestos NESHAP, this method is designed to be a work practice standard, monitoring of air (other than that mandated by OSHA statute), soil, and other media is not required.

2.11 Waste Handling

Several wastes are generated during demolition activities, including demolition debris, disposable PPE, and potentially contaminated water and soil, and must be properly disposed. All wastes generated must be removed from the site at the end of the day and transported to an appropriate disposal facility. Transport and disposal shall be in accordance with all federal, state, and local requirements. All waste haulers shall be leak-proof. Double-lining of the haulers with 4-mil or thicker polyethylene film and then sealing the top seams of the film is a suggested mechanism, but the contractor must do what is required to prevent leaks from the transport vehicles. Vehicles shall be decontaminated within the bermed area before leaving the demolition area.

2.12 Demolition Debris

Segregation of portions of a structure that may contain RACM from portions of a structure that clearly do not contain RACM shall be done when practical in an effort to minimize RACM debris. For example, segregation may be used if a large warehouse is being demolished and only a small portion (e.g., office space) contains RACM.

When segregation is not practical, all demolition debris shall be disposed as RACM in a licensed asbestos disposal facility. Debris shall be kept adequately wet during loading into containers. Containers shall be covered during transport.

2.13 Personal Protective Equipment (PPE)

All disposable PPE shall be disposed as RACM. Reusable PPE shall be decontaminated in accordance with OSHA standard practices.

2.14 Potentially Contaminated Water and Impervious Surfaces

No potentially contaminated water runoff is permitted from the site during the demolition period. All impervious surfaces will be thoroughly washed with water (not amended) before site closure.

Construction site best management practices shall be used to prevent water runoff. Drains and sewer connections must be capped or plugged prior to wetting. Berms and/or trenches must be created as necessary to prevent runoff of water from the demolition site. If possible, the bermed/trenched area should extend 25 ft from the building and/or loading area. If not possible, adjacent areas and structures need to be covered with plastic, or protective barriers constructed.

The berm/trench must be sufficiently spaced from the building to permit the movement of the demolition equipment and to allow the truck loading to occur within the enclosed space. All plastic shall be disposed as RACM.

If large water volume use or impermeable conditions surrounding the building create excessive water volume and simple containment and percolation is not feasible, the water must be pumped and either disposed as ACM or filtered through a series of filters ultimately removing all fibers equal to or larger than five microns before transporting to a publicly-owned treatment works or discharging to a sanitary sewer. The filters must be disposed as RACM.

2.15 Potentially Contaminated Soil

Following the removal of demolition debris, bare soil within the bermed area shall be excavated to a minimum depth of three inches or until no debris is found. Berms created shall also be removed and disposed as potentially asbestos-contaminated. All removed soil shall be disposed as RACM.

2.16 Site Closure

Following demolition and waste disposal, all waste and debris must be gone from the site and the site must be secured so as not to create a safety hazard.

SECTION 3 PROJECT OBJECTIVES

The goal of this research study was to determine and document the effectiveness of the AACM on a building containing RACM popcorn ceilings. All of the data collected were evaluated and considered, as appropriate, in undertaking this analysis.

The quality assurance project plan (QAPP), *Building Demolition Evaluation Phase III Study – Alternative Asbestos Control Method* (December 2007) was developed by to serve as the guide for collecting and analyzing the data from this research effort. The QAPP for AACM1 (the first AACM test comparing two buildings at Fort Chaffee) was formally peer-reviewed and offered for public comment and revised accordingly. The QAPP for AACM2 was revised from the first QAPP and was tailored to the AACM2 site and was reviewed by the QAPP Technical Development Team members. The QAPP for this site was revised from the QAPPs for AACM1 and AACM2. The following project objectives are specified for AACM3:

3.1 Primary Objective

1. To determine the airborne asbestos concentrations during the demolition of the subject building by the AACM process and compare to background concentrations.

3.2 Secondary Objectives

The following secondary objectives will provide additional information to further characterize the interrelationships among several multimedia parameters to enhance the understanding of the process and to further the science. These data will also be considered in a holistic sense in assessing the effectiveness of the AACM demolition method:

AIR

1. To document visible emissions during the AACM3 demolition.

2. To determine total fibers in air (phase contrast microscopy (PCM)) during the AACM3 demolition and compare to background concentrations.

DUST

3. To determine the settled dust asbestos loadings during the building demolition by the AACM3 process and compare those to background loadings.

WORKER

4. To determine worker breathing zone fiber concentrations (PCM) during the AACM3.

5. To determine worker breathing zone asbestos concentrations (TEM-transmission electron microscopy) during the AACM3.

SURROUNDING SOILS/PAVEMENT/BUILDING SLAB

6. To determine the asbestos concentration in post-cleanup soils, pavements, and/or concrete floor slab (TEM) from the AACM3 demolition and compare those to pre-demolition soils, pavements, and to background soils/pavement asbestos concentrations.

WATER

7. To measure the asbestos concentrations in the source water, the amended water during demolition, and the surface water from the AACM3 demolition.

TIME

8. To document the time required for all activities related to the demolition by the AACM3.

COST

9. To document the cost required for all activities related to the demolition by the AACM3 and to compare those with estimated costs for demolition of the building by the NESHAP process.

SECTION 4 SITE INFORMATION

4.1 Site Selection

The site selected for conduct of this study is the former office building for the Oak Hollow Apartment complex located at 5901 Boca Raton Boulevard, Fort Worth, Texas. The subject building was a two-story structure that was slab-on grade construction, as shown in Figure 4-1, with a building footprint of about 2150 ft^2. It appeared that the building was constructed with wood frame, and had exterior brick veneer applied to the lower portion of the structure. The upper portion of the structure used wood panel siding. The building had an asphalt shingled roof. The interior of the building contained a wallboard system that has a surface texture coating and a wallboard system ceiling with asbestos-containing “popcorn” ceiling texture. The wells had been painted, likely numerous times, using latex paint. Various flooring materials were present in the structure, including flexible tile with mastic and carpets. The only asbestos type found was chrysotile. The net area of RACM for cost estimation purposes was 7,900 ft^2 (5,700+2,200 ft^2). The City of Fort Worth conducted an asbestos survey of the building since it was one of many buildings in that complex scheduled for demolition. Table 4-1 presents the RACM identified during this inspection, combined with the subsequent re-inspection and re-analysis.

TABLE 4-1. RACM IDENTIFIED IN THE OAK HOLLOW APARTMENTS OFFICE

RACM Type	Description	Chrysotile, percent	Category	Amount, sq ft
Sheetrock	Popcorn Ceiling Texture	2-3	Non-Friable II	2,200
Sheetrock	Sheetrock , Joint Compound, and Wall Texture	2-3	Non-Friable II	5,700
Flashing	Chimney	5	Non-Friable II	61

Figure 4-1. Oak Hollow apartment complex office building.

The comprehensive pre-demolition inspection was conducted in accordance with the Asbestos Hazard Emergency Response Act (AHERA) (40 CFR 763) and the requirements of the ASTM E2356-04e1 Standard Practice for Comprehensive Building Asbestos Surveys to identify the type, quantity, location, and condition of Asbestos-Containing Materials (instead of only RACM) in the building in accordance with the Asbestos NESHAP and the Texas Department of State Health Services (DSHS) asbestos program requirements. As noted in the Asbestos NESHAP [40 CFR 61.145(a)], in addition to RACM, Category I and Category II Non-friable Asbestos-Containing Materials must also be identified prior to demolition or renovation.

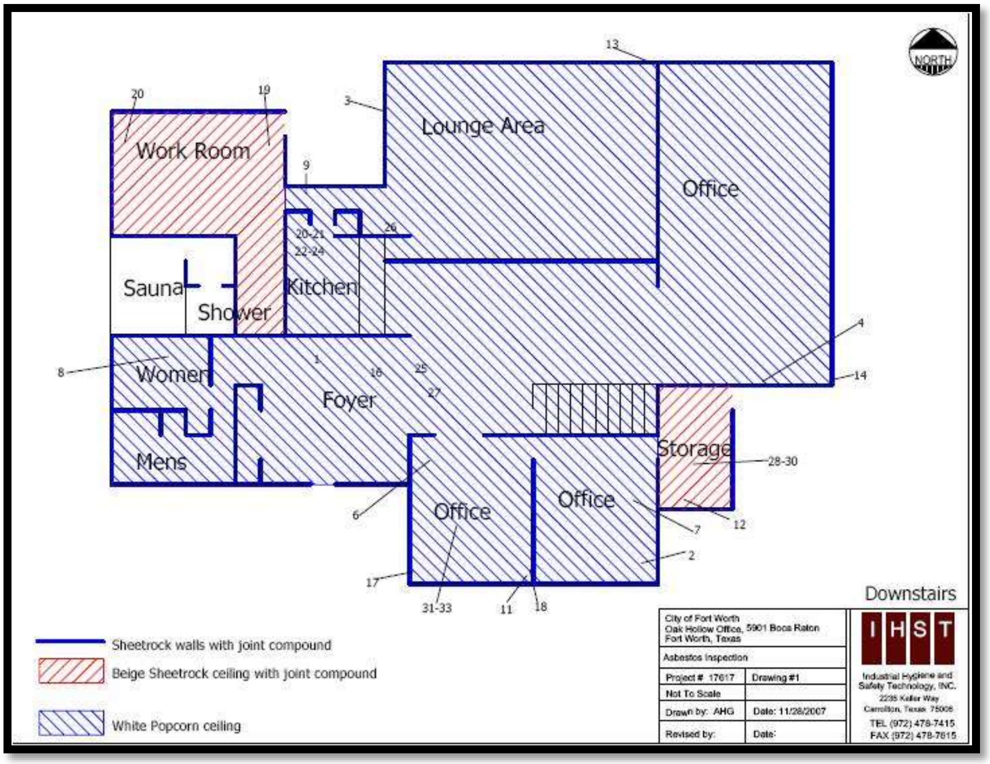

Figure 4-2. RACM areas identified on the ground floor.

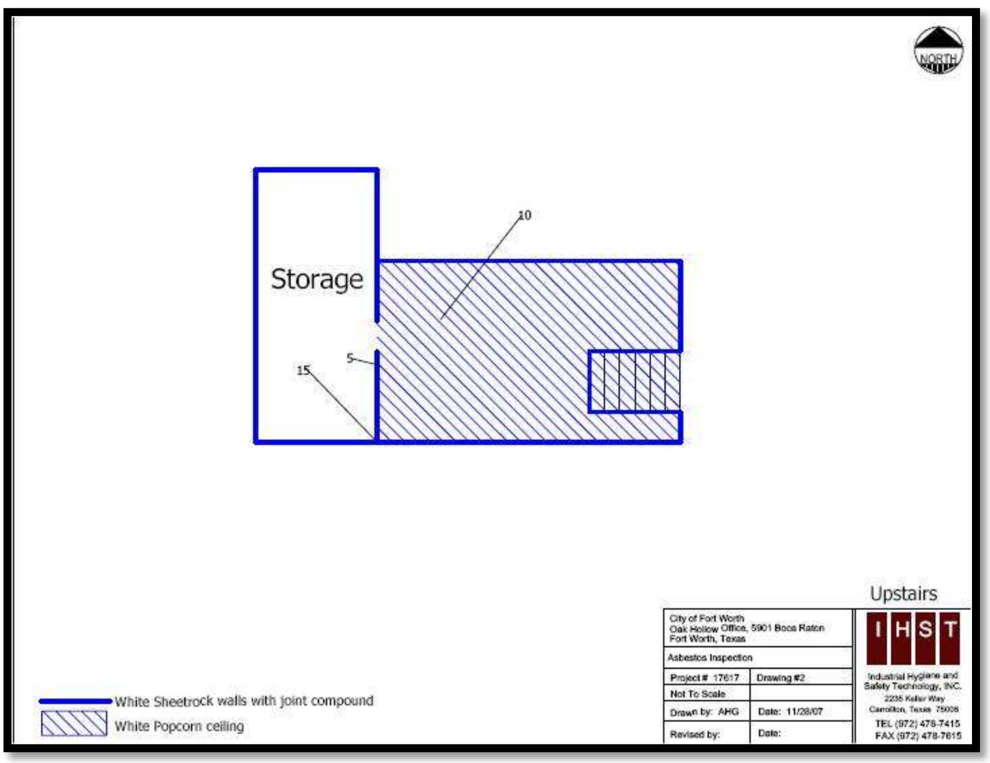

Figure 4-3. RACM areas identified on the second floor.

A resampling and subsequent reanalysis by different analytical laboratories yielded conflicting results. To be environmentally conservative, areas testing positive for asbestos by any of the laboratories used (greater than one percent) were judged to be asbestos-containing and listed as RACM. There was no disagreement on whether the popcorn ceiling was RACM as it tested positive in all the tests.

The building was surveyed for the presence of inorganic lead (*e.g.* lead paint) in accordance with Housing and Urban Development's (1997) "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" to characterize the potential for occupational exposure during demolition. Representative composite bulk samples of the suspect lead-containing building materials were collected in accordance with the HUD sampling protocols and analyzed to determine the lead content by EPA SW-846 Methods 3050B/7420. No lead was present in the paint chips, and as a result, lead was not a concern for either worker exposure or waste disposal.

Additionally, the electrical switches in the building were inspected and found to not contain mercury. The ballasts in the fluorescent lights were visually inspected and found to be labeled as "non-PCB containing." The fluorescent light tubes were removed from the building prior to demolition and properly disposed or recycled.

The area surrounding the project was primarily residential, including apartment complexes, townhouses and single-family homes, as shown on Figure 4-4 and Figure 4-5. The apartment complex that the subject building was located within and the apartment complex to the south, border in yellow, were acquired by the City of Fort Worth, ***were unoccupied***, and have since been demolished by the traditional NESHAP process. The apartment complex located to the southeast, across Boca Raton Boulevard, and the apartment complex to the north of the subject building were occupied. In addition, a low-density residential community is located approximately 300 feet to the northwest of the subject building site. A police substation is located approximately 500 feet southeast of the subject building site. For purposes of the evaluation, Boca Raton Boulevard was closed during the demolition. Additionally, the bus stop located along Boca Raton Boulevard was temporarily relocated. Also, a poly wall was built along Boca Raton Boulevard.by the City with the intention of providing additional protection against accidental release of asbestos in the direction of the occupied structures,

Figure 4-4. Aerial photograph of AACM3 site and surrounding area.

Figure 4-5. Closer aerial view of the popcorn-ceiling building site.

4.2 Building/Site Assessment and Description

Site assessment sampling and analyses for asbestos were performed in the air, soil, hydrant water and on the pavement surface. This sampling was conducted per "*Sampling and Analysis Plan Phase III AACM Building Inspection, Site Assessment Sampling and Analysis*" (Barrett 2007), using the same sampling and analytical techniques described in SECTION 5 and SECTION 6. Four air samples plus one blank, four hydrant water samples plus one blank, seven soil samples, and seven pavement dust samples were collected at the site on November 1, 2007, approximately six weeks prior to the study. Three pavement samples were collected from the sidewalk in the front and sides of the building, one on the covered patio to the rear of the building, and three samples within in the asphalt parking area. The air samples were spaced at four quadrants about 25 feet from the building. Three of the pavement samples were taken on the paved area in front of the popcorn-ceiling building and the remainder on the walkways and patio around and in the rear of the building. Soil samples were taken at each identifiable segmented area around the building (areas separated by walkways, etc). The water samples were taken at the hydrant near the building, after allowing the water to run until it was relatively clear (about 20 min). All asbestos counts include both long and short fibers. The results are presented in Table 4-2.

TABLE 4-2. SITE ASSESSMENT SAMPLE RESULTS

Parameter	Mean	Max	Min
Hydrant Water	ND (<0.05 ms/L)	ND (<0.05 ms/L)	ND (<0.05 ms/L)
Air	ND (<0.0005 s/cm^3)	ND (<0.0005 s/cm^3)	ND (<0.0005 s/cm^3)
Soil	ND (<6.8 x10^7 s/g)	ND (<6.8 x10^7 s/g)	ND (<6.8 x10^7 s/g)
Pavement/Walk Surface	15,000 s/cm^2	54,000 s/cm^2	ND (<730 s/cm^2)

ms/L = million asbestos structures per liter

4.3 Site/Building/Study Preparation/Neighborhood Protection

4.3.1 Legal Authority to Conduct the AACM Study

Since the building was a commercial facility containing regulated amounts of ACM (RACM) , the demolition was covered under the Federal Asbestos NESHAP; therefore, a No Action Assurance (NAA) was required from EPA's Office of Enforcement and Compliance Assurance (OECA) to allow the demolition to proceed using the AACM technology. This NAA was issued December 4, 2007 by OECA to EPA Region 6. Similarly, the City of Fort Worth required a No Enforcement Action (NEA) letter from the Texas Department of State Health Services. This NEA letter was issued December 10, 2007.

4.3.2 Barrier Wall

A close-proximity barrier wall, similar to that used in AACM2, was added to this study by the City of Fort Worth to add additional security against sudden wind changes that might have the potential to transport airborne materials toward the apartment complex across Boca Raton Boulevard. The barrier wall was constructed on the inside of the fence separating the sidewalk (which was closed during the demolition) and the paved access area to the building to be demolished. The barrier wall was covered with plastic sheeting. Pictures of the process are shown in Figure 4-6 through Figure 4-8. The use of the wall was not a part of the research; however, samplers were placed on the top of the wall to assess any potential asbestos release over the wall.

Figure 4-6. Barrier wall looking toward Boca Raton Boulevard.

Figure 4-7. Scaffolding and plastic covering for the barrier wall.

Figure 4-8. Barrier wall as seen from the entrance to occupied apartment complex.

4.3.3 Weather Restrictions

The demolition would not be conducted during rain or snow conditions as these conditions would affect the monitoring during this research effort. For this study, if sustained wind speeds of 15 mph (60-min average) or gusts above 20 mph were encountered, demolition and monitoring would pause until the wind speed was less than these conditions. The maximum limits were established to attempt to prevent the higher winds speeds from excessively modifying the micrometeorology and affecting the research results. Operations would have resumed upon the winds returning to stable conditions for 15-min minimum allowable within the confines of the test, or would be delayed until satisfactory conditions exist. Also, as an added protective measure, the demolition could not be conducted if the wind was blowing toward the occupied apartments across Boca Raton Boulevard. Wind conditions at the selected site were continuously monitored by the onsite weather stations. ***No excessive wind situations or improper wind directions occurred during the study.***

4.3.4 Public Awareness

A community outreach workgroup was formed between the City of Fort Worth staff and EPA project members (EPA and City community involvement teams, public relations teams, project managers, and environmental justice staff were included). It was through this workgroup (Figure 4-9 and Figure 4-10) that a public awareness program was developed for this research effort. The outreach strategy included utilization of the existing City of Fort Worth outreach tools such as a public meeting, which was held near the site, primarily for the benefit of all potentially affected neighbors. The public process provided the City of Fort Worth an outlet to make a final determination whether to move forward with participating in AACM3 in consultation with the City Council member Danny Scarth and Mayor of Fort Worth, Mike Moncrief. The public meeting also drew interest by non-residents, who believed that the City and EPA were excluding outside parties from participating and not providing the asbestos industry workers a voice. The City advertised the meeting through letters of notification and flyers to all potentially affected neighbors. The immediate neighborhood association also provided email notifications as well as posting of flyers in prominent places in the neighborhood and web posting of the meeting date on the City of Fort Worth meeting notifications site. The communication team members also provided individual meetings with additional neighborhood entities identified by the City. These entities assisted by providing input prior to the public meeting with the immediate residents impacted by this research project. The meetings were coordinated by the City of Fort Worth and the EPA communication staff.

In addition, separate meetings were held by EPA to brief the State of Texas Chapter of Environmental Defense, the State of Texas Chapter of the Sierra Club, the Dallas- Fort Worth Chapter of the Sierra Club, and two meetings to brief the Texas Department of State Health Services. In retrospect, EPA should have also made a greater effort to include local construction and asbestos abatement interests.

The City of Fort Worth also briefed the City Council, whose meetings are open to the public. In addition, both EPA and the City of Fort Worth had numerous press interactions to publicize the effort as well as listing all events, supporting documentation, and timetables on the EPA web site. Numerous press and personal interviews (Figure 4-11 and Figure 4-12) were conducted by EPA technical personnel and the demolition received significant radio, newspaper, and television news coverage.

Figure 4-9. Texas communication crew.

Figure 4-10. Planning for the public involvement for the study.

4.3.5 Summary of Neighborhood Protection employed by EPA and the City of Fort Worth

The Agency and the City of Forth Worth implemented the following actions to provide maximum protection of the neighborhood against accidental release of asbestos:

- Public meetings for the immediate neighborhood
- Public notification by phone, mail, flyers, web postings
- Discussions at Fort Worth City Council meetings
- Press briefings and interviews (newspaper, radio, and television)
- Briefings for Texas Department of State Health Services
- Briefings for Texas Chapters of Sierra Club and Environmental Defense
- Only conducting study when the wind was blowing away from the occupied apartments
- Conducting the study during the week, when children are in school and adults are at work
- Constructing barrier wall between demolition site and Boca Raton Boulevard
- Closing Boca Raton Boulevard during the demolition
- Re-routing bus traffic during the demolition, and
- Closing pedestrian access in front of the demolition site

Figure 4-11. Television coverage of the demolition.

Figure 4-12. Conducting television interviews about the project.

SECTION 5 STUDY DESIGN AND IMPLEMENTATION

5.1 Sampling Strategy

The overall summaries of the field samples collected for asbestos during the study are presented in Table 5-1, summarizing the numbers and type of samples collected for each media.

TABLE 5-1. SAMPLE SUMMARY FOR THE POPCORN-CEILING BUILDING

Description of Sample	Popcorn-Ceiling Building				
	Air[a]	**Soil**	**Pavement/ Surface**	**Water**	**Settled Dust**
Background	-[c]	4	4	-	-[c]
Pre-Demolition	-	6	4	-	-
Pre-Wetting					
Background	6	-	-	-	6
Ring	18	-	-	-	18
Water from hydrant	-	-	-	1	-
Amended Water	-	-	-	1	-
Workers	2	-	-	-	-
Demolition and Debris Removal					
Background	6[b]	-	-	-	6[d]
Ring	18 [b]	-	-		18[d]
Top of Wall	3 [b]	-	-	-	3
Adjacent Balconies	6[b]	-	-	-	6
In front of Apartment Complex	3 [b]	-	-	-	3
Water from hydrant	-	-	-	1	-
Amended Water	-	-	-	2	-
Surface Water	-	-	-	3	-
Workers	6	-	-	-	-
Post-Demolition	-	6	-	-	-
Soil Removal					
Background	6[b]	-	-	-	-
Ring	18 [b]	-	-	-	-
Workers	5	-	-	-	-
Post-Excavation	-	6	-	-	-
Equipment Decon and Pavement Cleaning					
Background	6[b]	-	-	-	-
Ring	18 [b]	-	-	-	-
Post-Cleaning	-	-	10	-	-
Workers	4	-	-	-	-
Total samples	**125**	**22**	**18**	**8**	**60**

[a] Samples were also analyzed for total fibers.
[b] Both high and low flow samples were taken; only the low flow ones were ultimately analyzed.
[c]Presented below for each sampling event.
[d]Samples composited over demolition, soil excavation, and decon/cleaning

5.1.1 Meteorological Monitoring

Meteorological conditions were determined and continuously monitored during sampling using a MetOne Automet Meteorological Monitoring Systems (Automet 466A). The meteorological parameters that were measured included wind direction and speed, air temperature, relative humidity, and barometric pressure. The backup meteorological system was a Pine Vantage Pro 2 and Vantage Pro Plus Wireless Station whose sensor was attached to the fence adjacent to the primary meteorological station.

5.1.2 Weather Restrictions

The demolition was not conducted during rain or snow conditions. For this study, if sustained wind speeds of 15 mph (60-min average) or gusts above 20 mph were encountered, demolition and monitoring would pause until the wind speed was less than these conditions. The maximum limits were established to attempt to prevent the higher winds speeds from excessively modifying the micrometeorology. Operations would resume upon the winds returning to stable conditions (15-min minimum allowable within the confines of the test), or would be delayed until satisfactory conditions exist. Wind conditions at the site were continuously monitored by the onsite weather station. Also, as an added protective measure, the demolition could not be conducted if the wind was blowing toward the occupied apartments across Boca Raton Boulevard. ***During the study, none of the weather restriction situations or improper wind directions were encountered.***

5.1.3 Demolition Site Sampling

5.1.3.1 Background Air Monitoring

Air and settled dust background monitoring as shown in Figure 5-1and FIGURE 5-2 was conducted during the demolition of the popcorn building to collect data necessary for comparison of air concentrations of asbestos and total fibers during demolition. The target air volume for an eight-hour sample at a flow rate of four liter/min was about 1900 liters.

The background air monitoring network consisted of six fixed-station samplers located about 600 ft upwind of the building, in the fenced-off area of the Oak Hollow Complex. The background monitoring was conducted simultaneously with the demolition.

Figure 5-1. Background sampler array.

Figure 5-2. Location of the background samplers.

5.1.3.2 Perimeter Air Asbestos, Total Fibers, and Settled Dust Sampling During Demolition

Two EPA dispersion models: SCREEN3 and ISCST3 were used to assist in sampler placement. The choice of a single ring of samplers at one height was based upon the lessons learned from AACM1. SCREEN3 (a Gaussian plume dispersion model) is a screening tool that uses a worst-case meteorology to produce a conservative one-hour average air concentration estimate. A refined modeling analysis was then conducted using the ISCST3 (a steady-state Gaussian model) to predict location (i.e., lateral distance and height above ground level) where the maximum concentration of airborne asbestos was likely to occur.

Modeling conducted using the EPA dispersion models SCREEN3 and ISCST3 indicated that the maximum airborne asbestos concentrations during demolition and loading of debris would most likely occur approximately 10-25 feet from the building at a height of ten to fifteen feet above the ground. The air samples were placed at a height of ten ft. Also, the samplers were placed approximately 25 feet from the face of the building. On the front side of the building, the samplers were positioned approximately 35 feet from the face of the building to accommodate the space needed for loading the construction debris disposal roll-offs. This provided about ten feet between the truck side and the building.

Eighteen samplers for asbestos/total fibers were evenly spaced at 20-degree intervals around the building in a ring at a ten-ft height. Eighteen dust samplers were positioned at a height of five feet on the same sampling pole supports. The perimeter air and dust samplers were placed immediately outside of the containment area. The samplers were in numerical order corresponding to the manner in which the samplers were placed around the buildings. That is, the first sample in each group of 18 corresponded to the location on the left-front corner of the building and then were subsequently numbered in a clockwise fashion around the structure. The roll-offs entered the containment area between samplers 13 and 14 and were loaded along the front of the building (samplers 15 through 18 in each grouping). Accumulated water on the pavement was designed to be pumped from a sump constructed on the pavement next to sampler 16, which was the low point for drainage from the paved area, but very little water accumulated there.

The perimeter air sampling network is shown for the popcorn-ceiling building in Figure 5-3.

Three additional asbestos/total fibers samplers and three additional dust samplers were placed at the top of the barrier wall at the front of the building (BR samples in Figure 5-3 and shown in Figure 5-8). In addition, three samplers were placed on the right and left building stair balconies, at an approximate height of 20 feet. Another three samplers were placed across Boca Raton Boulevard (which was closed) in front of the occupied apartment complex (WA samples in Figure 5-3 and shown in Figure 5-9).

Primary air samples (Figure 5-5 through Figure 5-9) were normally collected at an airflow rate of four liter/min for planned eight to ten hours to achieve a target air volume of near 1900 liters. Additionally, lower volume samples were collected at a flow rate of two liter/min for a planned eight to ten hours to achieve an air volume of near 1000 liters, to serve as backup samples if the primary ones were overloaded. The demolition took far longer than expected: therefore, many of the primary samples were overloaded. These low flow samples were normally the ones analyzed.

All air samplers were activated shortly before each phase of the demolition activities began, and were continued until that phase of the demolition activities ceased.

The meteorological monitoring station is shown in Figure 5-10.

Figure 5-3. Location of samplers around the popcorn-ceiling building.

Figure 5-4. Sampler number one at the left front of the building.

Figure 5-5. Typical air sampling array.

Figure 5-6. Samplers 15 through 18 in front of the barrier wall.

Figure 5-7. Sampling station 10.

Figure 5-8. Samplers on the one of the two balconies.

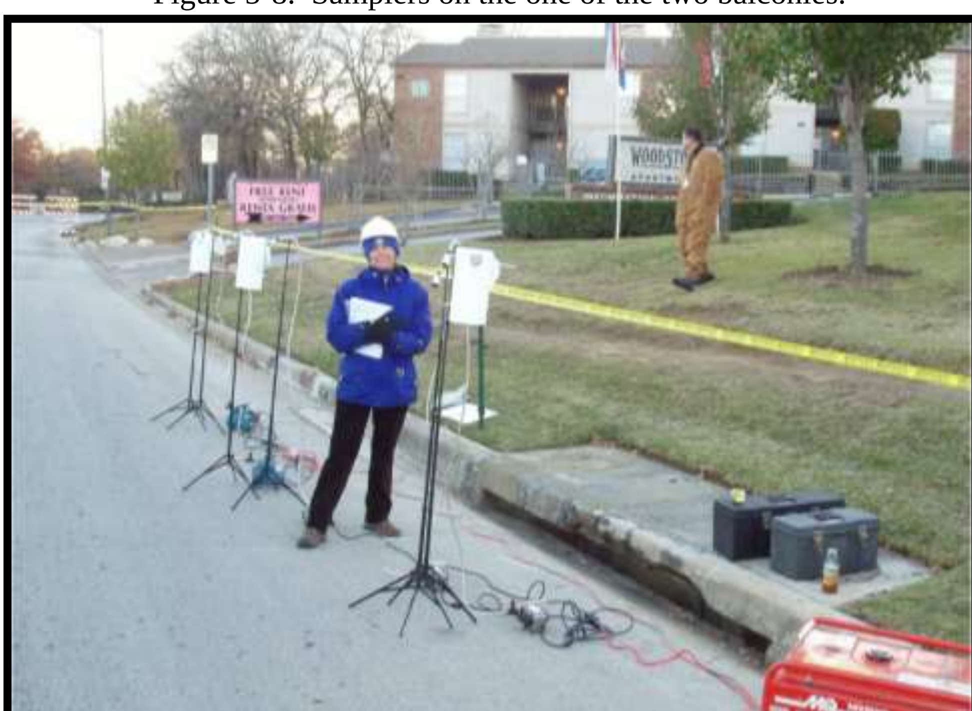

Figure 5-9. Samplers in front of the occupied apartments.

Figure 5-10. Meteorological sampling station.

5.1.3.3 Personal Breathing Zone Sampling During Demolition

Personal breathing zone samples were collected and analyzed for asbestos and total fibers from all workers directly involved with the demolition of the building and the handling of the resultant construction debris. For the building demolition, samples were collected during the demolition sampling periods to calculate the time-weighted average (TWA) concentration for comparison to the OSHA Permissible Exposure Limit for Asbestos (29 CFR §1926.1101). The samplers ran the entire time the individual was performing the specific assigned task.

5.1.3.4 Pavement Sampling

Pre-demolition pavement samples (Figure 5-11) were collected prior to demolition of the popcorn building. Then, after debris removal and site cleanup (Figure 5-12), an additional set of pavement samples were collected (post-cleanup). Following collection, a nail was driven into the pavement to denote the sampling location. Pavement samples were also collected to document background asbestos concentrations and these were collected in areas near the office complex.

The pavement area was sampled for asbestos using ASTM Method D 5755 – 03 entitled "Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading." Per the method, 10-cm x 10-cm areas were sampled with the microvac. The sampling was conducted with 0.45-micron filters for two-min duration at a rate of two liter/min. The samples were collected with the center of the sampling template about 10-cm away from the nail which denoted the pre-demolition sampling location.

The technique of collection of surface samples by the microvac technique is shown in Figure 5-11. The spot was marked on the pavement so that before and after samples could be taken near the same location. This identical protocol was used in this study.

Figure 5-11. Typical surface sampling on pavement (from AACM2).

Figure 5-12. Surface sampling on concrete slab at the popcorn-ceiling building.

5.1.3.5 Soil Sampling

Composite soil samples were collected from the within the portions of the site that had bare soil surface cover. Each composite soil sample was comprised of six separate grab subsamples. Each grab subsample was collected from an area measuring six-inches by six-inches with approximately a ½-inch depth. The area was delineated using a metal template, which helped ensure that each component of the six-part composite sample was of similar mass. Rocks and organic material (e.g., roots larger than ⅜-inch, surface grass covering) were excluded from the subsamples.

The soil samples were collected using a clean metal scooping tool (e.g., a garden trowel) and placed in a clean one-liter plastic container with lid. Between collections of each sample, the template and trowel were cleaned with detergent water and rinsed with non-asbestos containing water. Figure 5-13 illustrates the soil sample collection in process.

Figure 5-13. Collecting soil samples at the popcorn-ceiling building.

5.1.3.6 Water for Wetting Structure and Demolition Debris

5.1.3.6.1 Source Water

Measurements were taken of the asbestos concentrations of the source water from a flushed fire hydrant applied to control the particulate emissions during demolition and debris loading. A source water sample was collected at both the commencement and completion of the demolition activities.

5.1.3.6.2 Amended Water

Samples of the wetting agent/water mixture as applied during the AACM3 demolition were collected and analyzed for asbestos.

5.1.3.6.3 Surface Water from Demolition

As described in the following section, containment ditches and berms were constructed to trap water runoff during demolition and debris loading. The sampling of the collected runoff water was intended to be spaced over the duration of the demolition activity; however, minimal water accumulated.

5.2 Site Preparation

5.2.1 Surface Water Control

For this study, containment berms were constructed surrounding the paved area in front of the building. The natural drainage of the paved surfaces was toward the curb in front of the building and then from the left front of the building toward the right front of the building. The majority of water that accumulated on the paved area resulted from the final cleaning of the track- hoe and the paved surface where the roll-offs were loaded. A wet vac was used to collect this water in front of sample station 13.

Ditches were constructed (Figure 5-14) to capture water on the remaining three sides (left, right, and rear) of the building. The contractor chose to line the ditches with plastic, with the intention of channeling all runoff water into the left rear corner of the building where it would be collected and later filtered and disposed to the sanitary sewer. Only a few gallons of water collected in the plastic lined areas, and this was removed with the plastic, so the storage tank and filtering system was not used.

Containment for two sides the paved portion of the site utilized hay bales covered in plastic sheeting. The side where the roll-offs entered and exited used absorbent bags laid across the pavement.

Figure 5-14. Plastic-lined ditches in the rear of the building.

5.2.2 Sampling Network

The sampling stations were located on two-inch schedule 40 polyvinyl chloride (PVC) poles attached to onsite-fabricated pump stands constructed on 2x4's. The settled dust samplers were affixed to the standpipe with cable ties.

The asbestos sampling cassettes were connected to the 1/10 hp, 110 VAC pumps using Tygon® tubing. Electrical service to each sampling station was provided by surface extension cords from a single generator with a 200-amp main distribution panel. A back-up generator was onsite. All pumps were placed on a wooden table affixed to the standpipe. Figure 5-15 and Figure 5-16 illustrate sampling stations identical to those utilized in this study. Figure 5-17 illustrates the installation of the filters on the one of the stations in the perimeter sampling array.

Figure 5-15. Typical preparation of sampling station supports.

Figure 5-16. Typical samplers (high and low flow plus duplicate.

Figure 5-17. Installing filter cartridges on sampler arrays.

5.3 Demolition and disposal of the popcorn-ceiling building

The popcorn-ceiling building was demolished using the demolition practices specified in the "*Alternative Asbestos Control Method*" contained in SECTION 2.

- No asbestos-containing materials were removed prior to demolition of the popcorn-ceiling building.
- Demolition was accomplished by a track hoe.
- Demolition debris disposal was into double-lined roll-off boxes and then to the Waste Management Lewisville landfill.

5.3.1 Amended Water System

Amended water is water to which a surfactant (wetting agent) has been added to improve the penetrating capability of water. The surfactant reduces the surface tension of the water which allows it to penetrate a material where water might normally run off, and thereby to reach interior spaces of materials. For this study, the chosen surfactant was a Kidde Fire Fighting NF-3000 Class "A" Foam Concentrate (Figure 5-18). Foaming ingredients give water the ability to adhere briefly to vertical surfaces, which allows the water longer contact with the surface. The material safety data sheet (#NFC970) for NF-3000 is contained in the QAPP and in the AACM1 report. This wetting agent is similar to Kidde Fire Fighting product Knockdown® that is used by firefighters to aid in extinguishing a fire. It cost $12.40/gal. Other wetting agents are may be equally effective and may cost less.

The NF-3000 wetting agent was added to achieve target application strength of one percent concentration. According to the manufacturer, the surfactant is effective at significantly lower concentrations. Optimizing the application concentration nor the type or brand of surfactant were not research goals of this project.

Figure 5-18. Surfactant supply.

The system layout consisted of a hydrant equipped with a water meter, nitrile rubber weave construction fire hose, ball shutoff nozzle, and in-line eductor system. In contrast to AACM1 where a pump was used to assure adequate proportioning, the system employed here relied on the line pressure from the hydrant and the in-line eductors on each line to add and mix the surfactant to the hydrant water during application of water. The nozzles were operated in a full-open position to assure consistent proportioning. The transition from the pump used in AACM1 to the use of simple eductors and line pressure was planned and was also recommended by the peer panel who reviewed the AACM1 report. The surfactant application system used during demolition employed two matched 15-gpm non-aspirating variable-pattern nozzles and matching in-line eductor.

Surfactant proportioning was verified initially by performing conductivity measurements of the application flow throughout the duration of the AACM demolition process. According to the National Fire Protection Association (NFPA) Standard for Low-, Medium, and High-Expansion Foam (NFPA 11, 2005 Edition), there are two acceptable methods for measuring the surfactant concentration in water: (1) Refractive Index Method and (2) Conductivity Method. Both methods are based on generating a baseline calibration curve comparing percent concentrations (of pre-measured surfactant solutions) to the instrument reading. The method selected for the NF-3000 solution concentration determination for this study was the conductivity method.

As stated previously, the target application strength of the NF-3000 wetting agent was approximately one percent. Therefore, following the procedures contained in the NFPA 11 Standard using the Conductivity Method, three standard solutions were prepared using the hydrant water and the surfactant concentrate from the application system. The percent concentrations for the three standards were 0.5, 1.0, and 2.0 based on a target concentration of one percent. The conductivity of each surfactant solution standard was then measured and a plot created of the concentration versus conductivity. Figure 5-19 shows the plot serving as the baseline calibration curve for the test series.

At the beginning of the AACM demolition activities, the concentration of the surfactant was monitored by taking conductivity measurements as recommended by Kidde Fire Fighting. Sample collection took place after water flowed for enough time to assure a representative sample. The real-time sample conductivity measurements were compared with the baseline calibration curve (conductivity versus concentration) shown in Figure 5-19. A summary of the conductivity monitoring at the start of the demolition is presented in Table 5-2. With the exception of one instance where the nozzle flow was restricted by ice in the hose, the resulting concentrations based on conductivity measurements of the application flow show that surfactant concentrations were below one percent. From that point on, visual observations were adequate to tell if the surfactant was being added, as the water had a slight bubbling action (appearing somewhat soapy) as it was applied to the demolition.

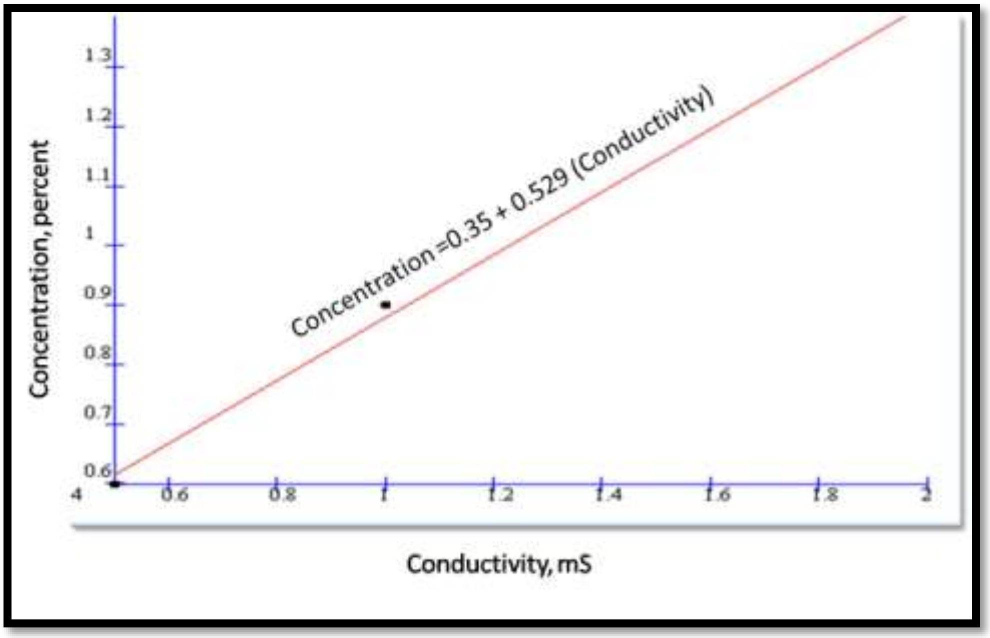

Figure 5-19. Calibration curve for the wetting agent.

TABLE 5-2. SUMMARY OF NF-3000 CONCENTRATION DURING DEMOLITION

Date	Time of Measurement (hours)	Number of Nozzles/Flow Rate, gpm	Conductivity, mS	NF-3000 Concentration (%) [a]
12.17.07	0820	Two/15	1.1	0.93
12.17.07	0835	Two/15	0.3	0.51
12.17.07	0845	Two/15	1.0	0.88

[a] Concentration was calculated based on the calibration curve (conductivity versus concentration) generated for the NF-3000 wetting agent and measured conductivity readings during the AACM3 demolition activities.

5.3.2 AACM Pre-Wetting

The popcorn-ceiling building was pre-wetted with two hoses on Sunday December 16, 2007, the evening before the demolition (Figure 5-20). After physically entering the building and wetting the interior, the amended water was applied to the exterior. This pre-wetting process required about an hour. One of the reasons for the choice of this building was that it was difficult to wet, as it had no attic in most of the structure; however, the effectiveness of the amended water in penetrating the substrate is apparent in Figure 5-21 through Figure 5-25.

Figure 5-20. Testing amended water flows prior to the pre-wetting the evening before the demolition.

Figure 5-21. Still very wet the next morning.

Figure 5-22. Some ceiling delamination occurred overnight.

Figure 5-23. Popcorn ceiling fragments on the floor.

Figure 5-24. More delamination.

Figure 5-25. Accumulated amended water in ceiling material.

On the day of the demolition (Monday December 17, 2007), both the interior and exterior were rewetted, taking about 45 min. Figure 5-26 through Figure 5-29 illustrate this process.

Figure 5-26. Preparing for wetting the day of the demolition (knocking out windows).

Figure 5-27. Wetting the interior.

Figure 5-28. Starting to wet the exterior on the morning of the demolition.

Figure 5-29. Wetting the building before the demolition.

In total, the pre-wetting process required roughly an hour on the day before the demolition and about 45 min on the day of the demolition.

5.3.3 AACM3 Demolition Phase

The demolition of the popcorn-ceiling building and removal of the building debris was conducted on Monday, December 17, 2007. Removal of soil was conducted on Tuesday, December 18th, and equipment decontamination (decon) was conducted on Wednesday, December 19. Amended water was used continuously during the demolition, soil removal, truck-loading operations, and the initial equipment decon. Water without surfactant was used for the final equipment decon and final pavement cleanup. Two 15-gpm nozzles were used to apply the amended water during demolition of the building and debris loading activities. A pressure washer worked best for the final equipment decon effort.

The trucks hauling the AACM debris to the landfill were lined with two layers of six-mil polyethylene. Prior to installing the plastic liner, the tailgate was additionally sealed from the inside with expanding urethane spray foam. This lining process took about 20-30 min per truck.

After loading of the debris, the two layers of plastic were folded together over the top of the truck bed and sealed with tape into a burrito-wrap configuration. This closing and sealing process required an average of approximately 20 min per roll-off.

The building demolition began at approximately 7:40 am and was completed at 7:30 pm. Site cleanup was completed by 8:00 pm. Temperatures that day began near freezing and warmed to the mid-fifties. Since the soil had not been removed, the site was covered with plastic overnight. On Tuesday, the plastic was removed and disposed as ACM. Soil removal began around 9:00 am and was completed about 5:00 pm. On Wednesday, pavement cleaning and decon of the track hoe started about 8:30 am and were completed about 4:00 pm.

EPA staff observed no visible emissions during the entire AACM demolition process.

Figure 5-30 through Figure 5-59 document the AACM demolition process.

Figure 5-30. Lined roll-offs.

Figure 5-31. Starting the demolition.

Figure 5-32. Making holes in the roof to the increase wetting.

Figure 5-33. More demolition progress.

Figure 5-34. More demolition progress.

Figure 5-35. More demolition progress.

Figure 5-36. More demolition progress.

Figure 5-37. More demolition progress.

Figure 5-38. More demolition progress.

Figure 5-39. More demolition progress.

Figure 5-40. Nearing the end of debris removal.

Figure 5-41. Final debris removal.

Figure 5-42. Soil removal.

Figure 5-43. Delivering the lined roll-offs.

Figure 5-44. Loading a lined roll-off.

Figure 5-45. Burrito-wrapping the debris in the roll-off.

Figure 5-46. Covering the burrito wrap to prepare the roll-off for removal.

Figure 5-47. Loading the covered roll-off onto the truck.

Figure 5-48. Removing the roll-off from the site.

Figure 5-49. Very little water in ditch liner.

Figure 5-50. Removing the ditch liners.

Figure 5-51. Nearing completion except for driveway cleaning.

Figure 5-52. Cleaning the track hoe.

Figure 5-53. Cleaning the track-hoe.

Figure 5-54. Cleaning the driveway.

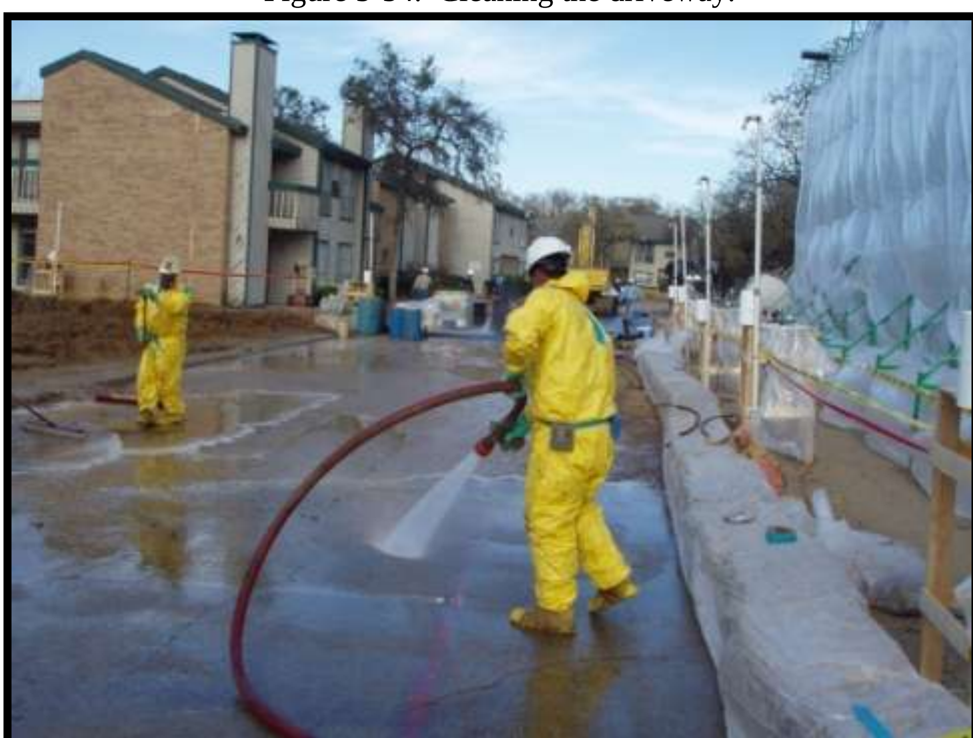

Figure 5-55. Cleaning the driveway.

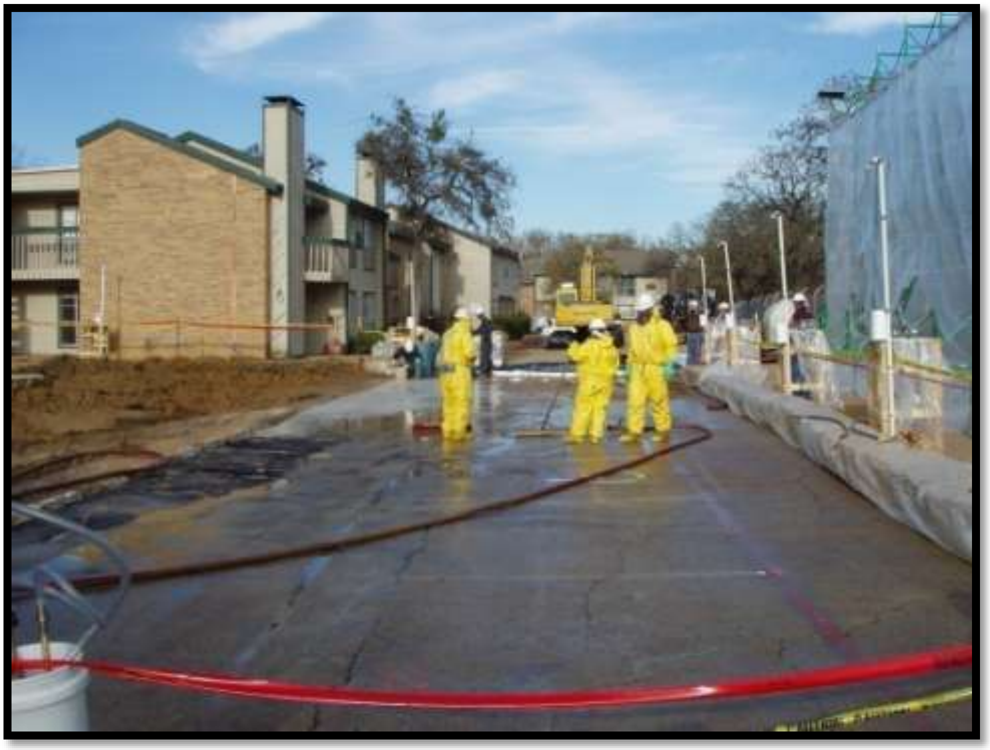

Figure 5-56. Driveway cleaning is almost finished.

Figure 5-57. Completing final load for landfill.

Figure 5-58. Awaiting transport to the landfill (note no leakage).

Figure 5-59. Site later after slab removal.

5.4 Meteorology During the Study

The winds during all phases of the study were fortunately calm and consistently blowing generally from the north- northeast with a maximum near eight mph. The temperature warmed from near-freezing on Sunday night to the seventies by completion of the study on Wednesday. All temperatures are degrees Fahrenheit.

5.4.1 Pre-wetting the day before demolition

The winds were calm, blowing generally from the south-southwest at an average of 2.2 mph with a maximum near four mph. The temperature averaged 39 degrees with a high of 50 and low of 31 degrees. The wind rose for the sampling period is shown in Figure 5-60.

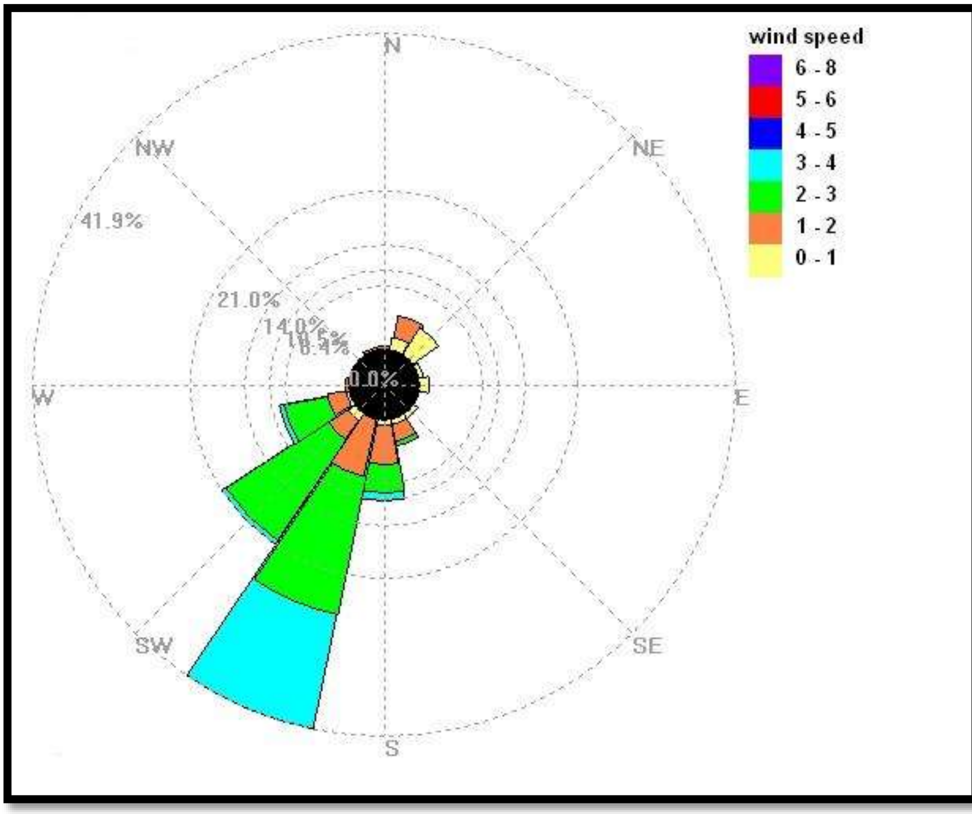

Figure 5-60. Wind rose during sampling during pre-wetting the evening before the demolition.

5.4.2 During demolition

The winds again were calm, blowing generally from the south-southwest at an average of 4.7 mph with a maximum near seven mph. The temperature averaged 47 degrees with a high of 55 and low of 34 degrees. The wind rose for the sampling period is shown in Figure 5-61 .

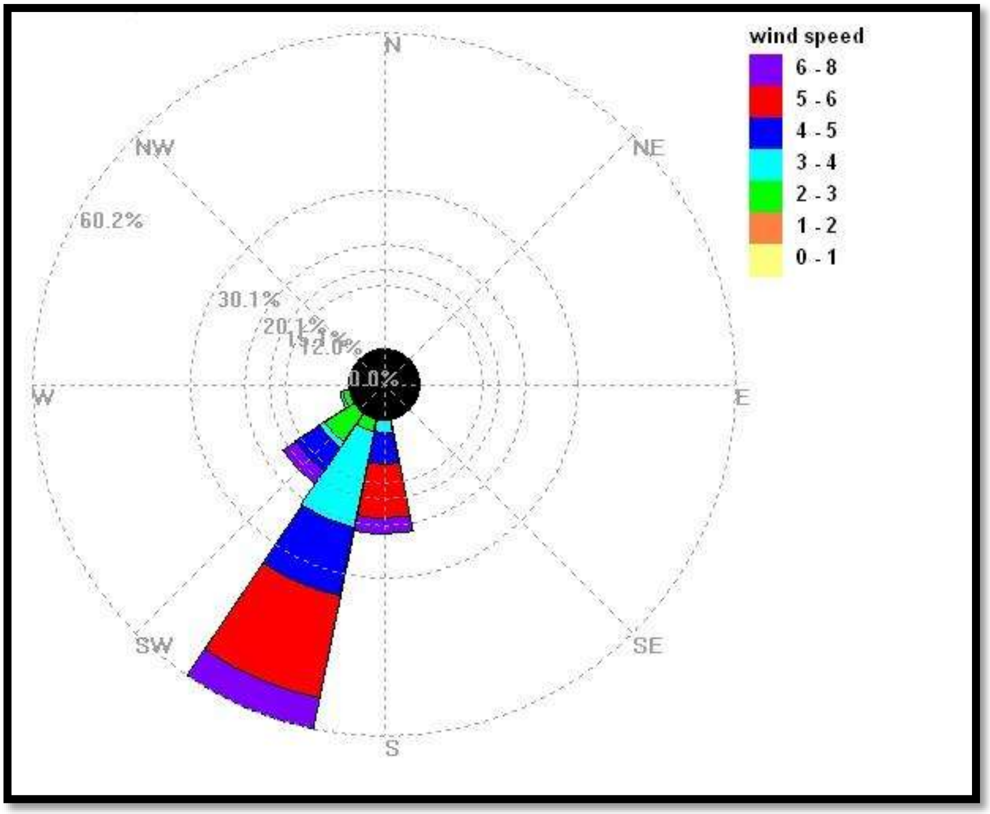

Figure 5-61. Wind rose during sampling during the demolition.

5.4.3 During soil removal

The winds were still calm, still blowing generally from the southwest at an average of five mph with a maximum near eight mph. The temperature averaged 63 degrees with a high of 75 and low of 44 degrees. The wind rose for the sampling period is shown in Figure 5-62.

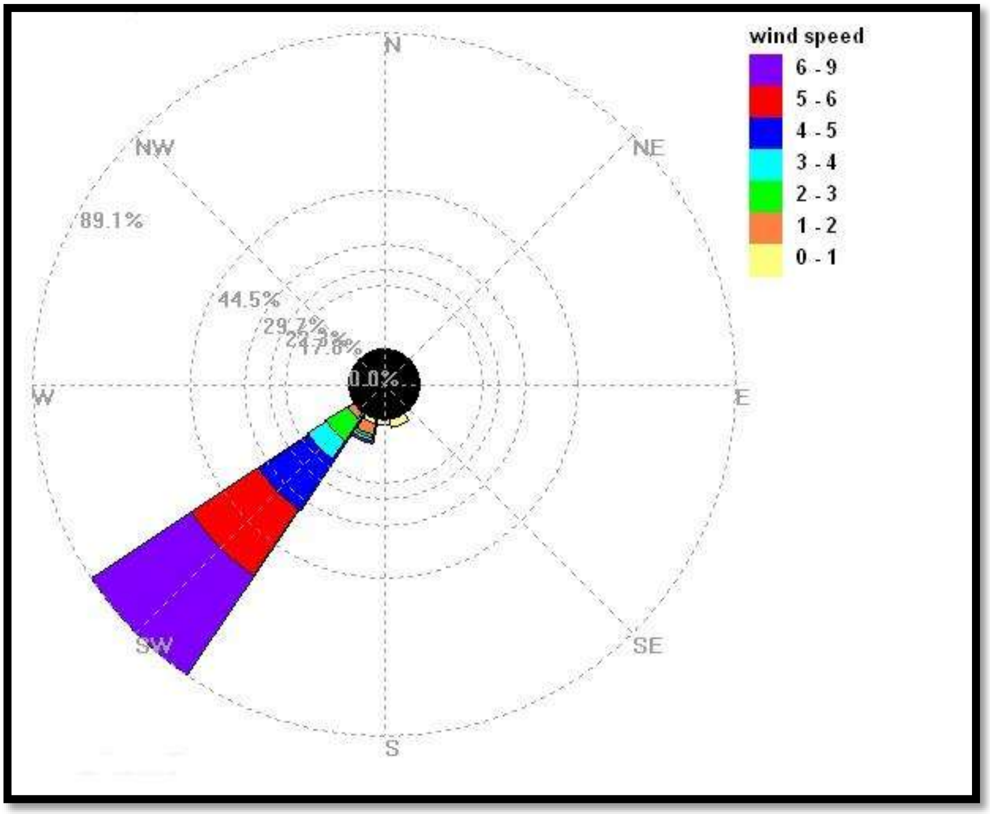

Figure 5-62. Wind rose during sampling during soil excavation.

5.4.4 During Equipment Decon/ Pavement Cleaning

The winds were still calm, still blowing generally from the south-southwest at an average of two mph with a maximum near four mph. Only personnel samplers were taken during this stage of the effort. The temperature averaged 63 degrees with a high of 56 and low of 39 degrees. The wind rose for the period is shown in Figure 5-63.

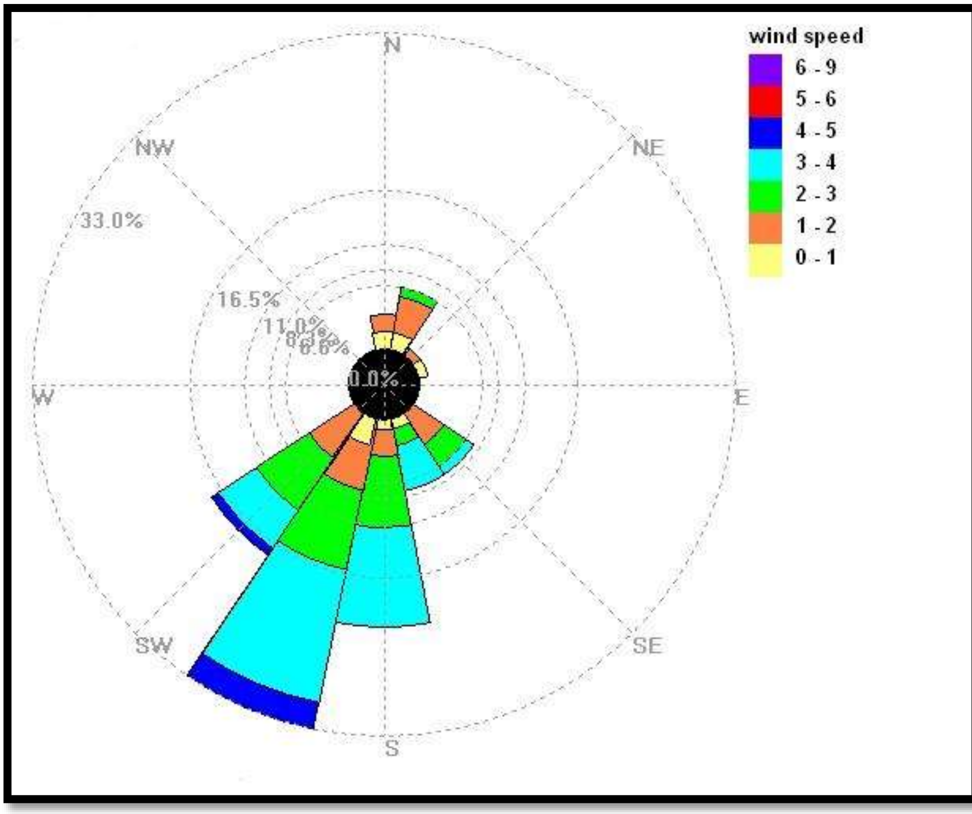

Figure 5-63. Wind rose during equipment decon and pavement cleaning.

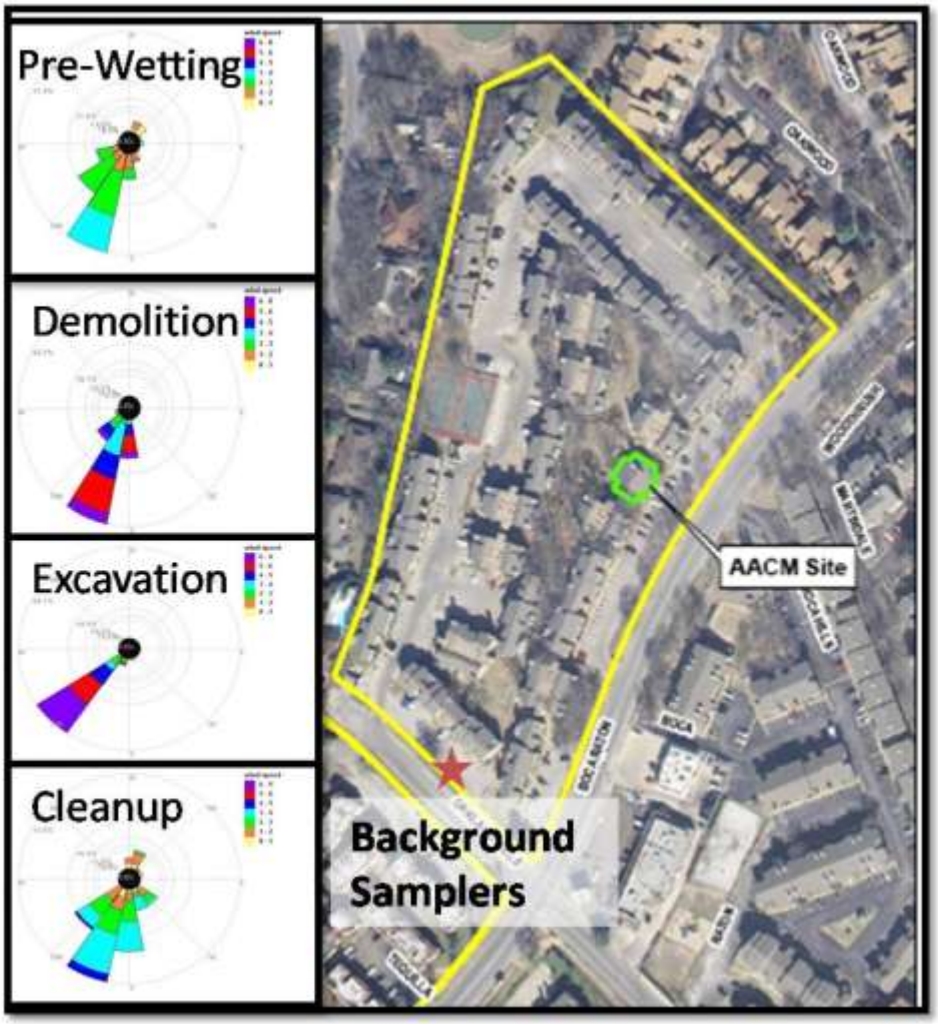

Figure 5-64. Site with wind rose overlay.

SECTION 6 SAMPLING AND ANALYTICAL METHODOLOGY

6.1 Sampling Method Requirements

6.1.1 Perimeter Air Sampling for Asbestos/Total Fibers

The samples for both asbestos and total fibers analysis were collected on the same open-face, 25-mm-diameter 0.45-µm pore size mixed cellulose ester (MCE) filters with a 5-µm pore size MCE diffusing filter and cellulose support pad contained in a three-piece cassette with a 50-mm conductive cowl. This design of cassette has a longer cowl than the design specified in ISO 10312:1995, but it has been in general use for some years for ambient and indoor air sampling. Disposable filter cassettes with shorter conductive cowls, loaded with the appropriate combination of filter media of known and consistent origin, do not appear to be generally available.

The filter cassettes were positioned on a sampling pole that accommodated cassette placement at ten feet above ground. The filter face was positioned at approximately a 45-degree angle toward the ground. At the end of the sampling period, the filters were turned upright before being disconnected from the vacuum pump, capped, and then stored in this position.

The filter assembly was attached with flexible Tygon® tubing (or an equivalent material) to an electric-powered (110-volt alternating current) 1/10-hp vacuum pump operating at an airflow rate of approximately four liter/min for the high volume and two liter/min for the low volume samplers. Every two hours, the flow rate for each pump was measured and adjusted if it deviated more than ten percent from the target value.

6.1.2 Personal Breathing Zone and Work Area Sampling for Asbestos/Total Fibers

Asbestos/Total Fibers—Personal breathing zone and work area samples were collected on open-face, 25-mm-diameter 0.8-µm pore size MCE filters with a cellulose support pad contained in a three-piece cassette with a 50-mm conductive cowl. The filter assembly was attached to a constant-flow, battery-powered vacuum pump operating at a flow rate of two liters per min.

6.1.3 Meteorological Monitoring

Two portable meteorological stations were used for the meteorological data recording. The principal one, manufactured by Met One Instruments, Inc., was equipped with AutoMet Sensors to record five-min average wind speed and wind direction data, as well as temperature, barometric pressure, and relative humidity. The data files were downloaded and archived using an on-site personal computer. The backup meteorological system was a Pine Vantage Pro 2 and Vantage Pro Plus Wireless Station.

6.1.4 Settled Dust Sampling

Settled dust samples for asbestos analysis were passively collected using EPA-modified ASTM Method D 1739-98 *"Method for Collection and Measurement of Dustfall (Settleable Particulate Matter)."* The collection container was an open-topped cylinder approximately six inches in diameter with a height of 12 inches. The container was fastened to the same sampling pole as the air samples at a height of five feet above the ground. The sampling time for the ASTM protocol was extended one hour beyond the end of demolition activity. Wind shields were not used. Upon completion of sampling, the dust collection container was capped and sealed for shipment to the laboratory.

6.1.5 Pavement Sampling

Pre-demolition pavement samples were collected prior to demolition of the popcorn building. Then, after debris removal and site cleanup, an additional set of pavement samples were collected (post-cleanup). Following collection, a nail was driven into the pavement to denote the sampling location. Pavement samples were also collected to document background asbestos concentrations and these were collected in areas near the office complex.

The pavement area was sampled for asbestos using ASTM Method D 5755 – 03 entitled "Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading." Per the method, 10-cm x 10-cm areas were sampled with the microvac. The sampling was conducted with 0.45-micron filters for two-min duration at a rate of two liter/min. The samples were collected with the center of the sampling template about 10-cm away from the nail which denoted the pre-demolition sampling location.

6.1.6 Soil Sampling

Composite soil samples will be collected from the within the portions of the site that has bare soil surface cover. Each composite soil sample will be comprised of six separate grab subsamples. Each grab subsample will be collected from an area measuring six-inches by six-inches with approximately a ½-inch depth. The area will be delineated using a metal template, which helps ensure that each component of the six-part composite sample will be of similar mass. Rocks and organic material (e.g., roots larger than ⅜-inch, surface grass covering) will be excluded from the subsamples.

The soil samples will be collected using a clean metal scooping tool (e.g., a garden trowel) and placed in a clean one-liter plastic container with lid. Between collections of each sample, the template and trowel will be cleaned with detergent water and rinsed with non-asbestos containing water.

6.1.7 Water Sampling—Flush Hydrant, Amended Water, and Pooled Surface Water

The sample container was an unused, one-liter pre-cleaned, screw-capped amber glass bottle. Prior to sample collection, the water from the water source was allowed to run for a sufficient period to ensure that the sample collected was representative of the source water.

Approximately 800 milliliters of water for each sample were collected. An air space was left in the bottle to allow efficient re-dispersal of settled material before analysis. A second bottle was collected and stored for analysis if confirmation of the results obtained from the analysis of the first bottle was required.

The samples were transported to the laboratory and filtered by the laboratory within 48 hours of sample collection. No preservatives or acids were added. At all times after collection, the samples were stored in the dark at about 5° C (41° F) in order to minimize bacterial and algal growth. The samples were not allowed to freeze because the effects on asbestos fiber dispersions are not known. On the same day of collection, the samples were shipped in a cooler at about 5° C (41° F) to the lab for analysis via one-day courier service.

6.2 Analytical Methods

6.2.1 Air Samples (TEM)

Perimeter Samples—The 0.45-µm pore size MCE air sampling filters were prepared and analyzed using EPA-modified ISO Method 10312:1995, *Ambient Air - Determination of Asbestos Fibres - Direct-Transfer Transmission Electron Microscopy Method.*" Note: After TEM analysis, a sector from the same filter was then analyzed using PCM by NIOSH 7400.

Personal Samples— The 0.8-µm pore size MCE air sampling filters were prepared and analyzed using EPA-modified ISO Method 10312:1995, *Ambient Air - Determination of Asbestos Fibres - Direct-Transfer Transmission Electron Microscopy Method.*" Note: After TEM analysis, a sector from the same filter was then analyzed using PCM by NIOSH 7400.

6.2.1.1 TEM Specimen Preparation

TEM specimens were prepared from the air filters using the dimethylformamide (DMF) collapsing procedure of ISO 10312:1995, as specified for cellulose ester filters. DMF was used as the solvent for dissolution of the filter in the Jaffe washer. For each filter, a minimum of three TEM specimen grids were prepared from a one-quarter sector of the filter using 200 mesh-indexed copper grids. The remaining part of the filter was archived in the original cassette in clean and secure storage.

6.2.1.2 Measurement Strategy

1. The minimum aspect ratio for the analyses was 3:1, as permitted by ISO 10312:1995. As required in the ISO method, any identified compact clusters and compact matrices were counted as total asbestos structures, even if the 3:1 aspect ratio was not met.

2. Table 6-1 presents the size ranges of structures that were evaluated, target analytical sensitivities, and stopping rules for each TEM method. The laboratories adjusted individual numbers of grid openings counted based upon the counting rules, the amount of material prepared for each sample, and the air volume, as applicable.

3. The structure counting data was distributed approximately equally among a minimum of three specimen grids prepared from different parts of the filter sector.

4. The TEM specimen examinations were performed at approximately 20,000x magnification.

5. PCM-equivalent asbestos structures, as defined by ISO 10312:1995, were also determined.

6. The type of structure was specified. In addition to classifying structures as one of the six NESHAP-regulated asbestos types, any other amphibole mineral particles meeting the aspect ratio of $\geq$3:1 and lengths $\geq$0.5 µm) were required to be recorded, if present (e.g., winchite, richterite). **However, none of these non-regulated amphiboles were observed.** Reference to or implication of use of either of the terms cleavage fragments and/or discriminatory counting did not apply.

TABLE 6-1. TEM TARGET ANALYTICAL SENSITIVITY, SIZE RANGE, AND STOPPING RULES

Method	Target Analytical Sensitivity	Structure Size Range	Stopping Rules
Modified ISO 10312:1995 Perimeter Air Direct Preparation	0.0005 s/cm^3	All Structures (minimum length of 0.5 µm; aspect ratio ≥3:1)	Count a minimum of four grid openings. If >100 structures are identified, counting is stopped. If <100 structures are identified, count until 100 structures are identified or the required number of grid openings to achieve target analytical sensitivity.
Modified ISO 10312:1995 Worker Air Direct Preparation	0.005 s/cm^3		
EPA/600/R-93/116, 1993 Soil	0.1%		
Modified ASTM D 5755-03			
- Settled Dust	250 s/cm^2		
- Pavement Dust	1000 s/cm^2		
Modified EPA 100.2			
- Hydrant/Amended Water	0.05 million s/L		
- Surface Water	2 million s/L Surface		

6.2.2 Air Samples (PCM)

Perimeter Samples—The 0.45-µm pore size MCE air sampling filters were prepared and analyzed for total fibers using NIOSH Method 7400 "*Asbestos Fibers by PCM*" ("A" Counting Rules). Fibers greater than five µm in length and with an aspect ratio greater than 3:1 were counted.

Personal Samples—The 0.8-µm pore size MCE air sampling filters were prepared and analyzed for total fibers using NIOSH Method 7400 "*Asbestos Fibers by PCM*" ("A" Counting Rules). Fibers greater than 5 µm in length and with an aspect ratio greater than 3:1 were counted.

6.2.3 Settled Dust Samples (TEM)

The analytical sample preparation and analysis for asbestos followed Modified ASTM Standard D5755-03 "*Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading*", modified as described in the following discussion. The sample collection container was rinsed with approximately 100 ml of 50/50 mixture of particle-free water and reagent alcohol using a plastic wash bottle. The suspension was poured through a 1.0 by 1.0 mm opening screen into a pre-cleaned 500 or 1000 ml specimen bottle. All visible traces of the sample contained in the collection device were rinsed through the screen into the specimen bottle. The washing procedure was repeated three times. The volume of the suspension in the specimen bottle was brought to 500 ml with particle free water. An aliquot of this suspension was filtered onto a MCE filter. These filters were prepared and analyzed using Modified ISO 10312:1995.

The measurement strategy and stopping rules provided in Table 6-1 were used, as applicable to settled dust.

6.2.4 Water Samples

The asbestos content of the water samples was determined using EPA Method 100.2 "*Analytical Method Determination of Asbestos in Water*", modified to count all structures greater than or equal to 0.5 µm in length and with an aspect ratio of greater than or equal to 3:1.

The measurement strategy and stopping rules provided in Table 6-1 were used, as applicable to water.

6.2.5 Soil

Soil samples will be analyzed for asbestos using EPA's "*Method for the Determination of Asbestos in Bulk Building Materials*" (EPA/600/R-93/116, July 1993). The specific procedures for implementing this method for the soils in this study are provided in the QAPP. The counting rules were modified as described in Table 6-1.

6.2.5.1 Soil Preparation

The composite soil samples will be shipped to the laboratory where the samples will be dried and homogenized as described in the Standard Operating Procedure (SOP) in the QAPP. Soil samples will be analyzed for asbestos using EPA's "Method for the Determination of Asbestos in Bulk Building Materials" (EPA/600/R-93/116, July 1993).

6.2.6 Pavement

The analytical sample preparation and analysis for asbestos followed EPA-modified ASTM Standard D5755-03 "*Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading*." The counting rules were modified as described in Table 6-1.

SECTION 7 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) RESULTS

Due to the potential use of the results of this research study in assisting in the evaluation of an alternative method to current regulations, the project was designated a NRMRL QA Category 2. Based on this designation, QA/QC activities for the study included the development of a detailed quality assurance project plan (QAPP), field and laboratory audits, analysis of multiple QA/QC samples, and data verification.
.

7.1 QAPP Development

The QAPP was prepared to conform to EPA QA/R-5, *Requirements for QAPPs, EPA/240/B-01/003, March 2001*. The QAPP, entitled *Building Demolition Evaluation Phase 3 Study of the Alternative Asbestos Control Method,* was QA-approved on 12/05/07.

7.2 Audits

A field audit and a laboratory audit were conducted. The following definitions were used:

> Findings were defined as: Non-conformances at the project level that have had or will have a significant adverse effect on quality.
>
> Observations were defined as: Non-conformances at the project level that will not have a significant adverse effect on quality.

7.2.1 Field Audit

A Technical Systems Audit was conducted at the demolition site in Fort Worth, Texas. The purpose of this audit was to review the implementation of the QAPP during demolition activities. The audit was conducted by David Gratson of Neptune and Company (a contractor to USEPA), with oversight by Lauren Drees, the EPA NRMRL QA Manager. The audit occurred over several days, including Wednesday, December 12, 2007; Sunday afternoon December 16, 2007; and Monday December 17, 2007. The plan was to observe the demolition and sampling preparations prior to the overnight wetting period that was scheduled to occur on December 12. Due to weather conditions (raining), the overnight wetting and demolition were delayed until December 16 and 17, respectively. During the audit, several EPA and contractor personnel were present, including Roger Wilmoth (EPA Program Manager), William Barrett (EPA Project Manager), Lauren Drees (EPA QA Manager), Seth Schultz (LBG Project Manager), Craig Napolitano (LBG QA Manager), and Holly Wootten (Cadmus Program Manager).

The audit included reviews of the following:

- Flow meter calibration procedure and records
- Sampling procedures for all matrices
- Inspection of the weather monitoring station at the demolition site

- Sampling data forms

No findings were identified. Table 7-1 provides a summary of the Observations that were identified during the audit. These Observations did not have a significant effect on data quality, but, when corrected, data collection efficiency was improved and ambiguity was minimized.

TABLE 7-1. SUMMARY OF AUDIT OBSERVATIONS AND CORRECTIVE ACTIONS

No.	Observation	Corrective Action
1	The QAPP states, "The soil samples will be collected using a clean metal scooping tool (e.g., a garden trowel) and placed in a clean one-liter plastic container with lid." While the LBG was preparing to collect the first set of soil samples on December 12th, they indicated their belief that the use of one-liter containers was not correct for soils. It was their intent to collect soils in four-ounce glass jars. Their plan was to prepare composites (six grab samples then composited in a stainless steel bowl) as described in the QAPP but take a subsample of the composite for the glass jar. This approach would have been inconsistent with the QAPP and may have resulted in a sample that was not representative of the sampling area.	The LBG was instructed to follow the QAPP and collect samples in 1-liter containers, which they did. Including the total soil composite is important due to the non-homogeneous nature of asbestos in soil. Laboratory preparation steps have been developed to ensure they are dried and homogenized prior to analysis. Since the laboratory preparation steps are integral to the overall representativeness of each sample, reducing the volume of sample that was homogenized at the laboratory would have increased the potential for less accurate samples.
2	The source water used during the demolition required amendment with a surfactant wetting agent. The QAPP requirement was to ensure the source water contained approximately a 0.50 percent concentration of surfactant (this target was changed to one percent in the field). To verify this objective during the wetting, the conductivity of the amended water needed to be analyzed. The process for doing this involved preparing three amended waters at 0.5, 1.0 and 2.0% (by volume) wetting agent. There was some uncertainty by the LBG as to how this should be done and how to read the Hanna pH/conductivity meter.	Steps were taken to ensure the LBG worker understood how to read the Hanna meter and help was provided in preparing the three solutions for the calibration curve.
3	For some perimeter samples, due to sample pump vibration, the direction of cassettes migrated during the sampling period. Also, for the samplers positioned on the balconies of the adjacent buildings, the high and low-flow samples were initially not positioned close to each other (sometimes separated by several feet).	Repositioning was performed as needed.
4	The QAPP requires that the flows for the worker sampling pumps be checked every two hours. A discussion with the IHST representative (subcontractor to LBG) prior to sample initiation indicated that he was not aware of this requirement.	Upon hearing that some field staff did not seem to be aware of the frequency of calibration checks, the LBG Project Manager spoke with all staff again about the frequency that calibration checks were to be performed.

No.	Observation	Corrective Action
5	It was observed that some of the supplemental and background settled dust containers overturned briefly due to wind.	Sampling personnel were instructed to document these occasions. Berger also created a method of providing additional support to the supplemental and background settled dust containers utilizing 2”x4” studs which prevented them from continuing to tip over in the wind. Any potential impacts on sample results should be evaluated.
6	During the audit, several deviations from the QAPP were identified. While these deviations do not adversely affect data quality, they need to be documented to provide an accurate account of project activities.	QAPP deviations were documented on site and will be reflected in the final report as necessary.
7	During the post-demolition soil sampling, it was observed that the top layer was being scraped and then discarded by one of the two sampling teams. The next layer was then scraped and collected. However, any asbestos in the soil following demolition would most likely be in this top layer.	The LBG Project Manager was consulted and he explained the correct procedure to the sampling team performing the sample collection incorrectly. One sample needed to be collected again using the proper procedure. All samples were collected as per the QAPP.
8	In most cases, a primary standard was used to measure the flow rates of the sampling pumps. However, due to time constraints, a secondary rotameter was used in some cases. It was sometimes not clear whether the flow rate documented represented the observed reading or the actual flow rate based on the appropriate calibration factor.	Due to time constraints, in some instances, actual flow rates were recorded. Prior to sending the samples to the lab all field notes and COC were thoroughly reviewed and all calibration correction factors were applied prior to sending the samples to the lab.
9	In observing the collection of the first set of water samples, it was noticed that the sample container was not being rinsed with the water prior to sample collection.	All water sample containers were rinsed with the sample water prior to sample collection.

7.2.2 Laboratory Audit

An audit of Bureau Veritas in Kennesaw, GA was conducted on January 16, 2008 by Sandra Anderson of Battelle Memorial Institute through a subcontract agreement with Neptune & Company, under a QA support contract with EPA. Audit activities were overseen by Lauren Drees, the EPA NRMRL QA Manager.

The laboratory was conducting analysis of air samples collected for asbestos and fibers by TEM and PCM, respectively. The audit focused on the following key areas: project management/QA management; sample receipt/sample storage; chain-of-custody procedures; analytical method requirements for air, settled dust/pavement dust and water samples; laboratory QC checks of the different sample matrices; instrument/equipment testing, inspection and maintenance; instrument calibration and frequency; data reduction, validation and reporting; and laboratory records and guidance documents.

Three findings and four observations were identified. Table 7-2 provides a summary of the issues that were identified during the audit. These issues did not yet have a significant effect on data quality, but, when corrected, data collection efficiency was improved and ambiguity was minimized.

Table 7-2. SUMMARY OF AUDIT ISSUES AND CORRECTIVE ACTIONS

No.	Finding/Observation	Corrective Action
1	Alan Segrave is currently the project manager and responsible QA Manager for Phase 3 laboratory analyses at Bureau Veritas North America, Inc. This situation presents a potential conflict of interest.	Alan Segrave will serve as the QA Manager; two other employees will serve as Project Managers.
2	QAPP Section B.3 requires documentation of "constant secure custody during …, and analytical stages." Section B.3.2 then states "Chain-of-custody procedures will be maintained in the analytical laboratory." The Bureau Veritas Quality Manual, Section 5.8,1, indicates that record of possession and control is maintained by the laboratory. However, these internal custody procedures and records are not available in the laboratory.	Bureau Veritas provided evidence of a functioning sample custody process. All samples are tracked through a LIMS system. All samples for this project will be secured in a designated locked position. A log will be maintained for sample removal.
3	Due to the additional time required to complete the demolition, significantly more samples were collected than planned (e.g., perimeter samples, worker samples, pavement samples) The numbers of QC checks specified in Table 24 of the QAPP are no longer applicable and need to be increased to ensure that sufficient checks are performed.	The LBG generated a new list of QC check requirements and provided it to Bureau Veritas.
4	Double containment of samples by use of plastic bags or secondary containers is recommended where possible. Where stored blanks and quality control samples are intermingled with actual samples, the laboratory should consider placing these samples on upper shelves to avoid possible cross-contamination in case of spillage. Should field samples arrive in double containers, these samples should continue to be stored and archived in clean secondary containers. Calibration status of thermometer S/N 41530576 used to document refrigeration temperatures for Phase 3 water samples should be added to laboratory records. Should the thermometer calibration actually have expired, a QAPP deviation report that includes the impact on stored sample integrity and stability will need to be written and added to Phase 3 laboratory records.	Double bags will be used for all project samples. Stored blanks and QC samples will be stored away from project samples to avoid cross-contamination. The identified thermometer will be added to the calibration inventory list; it was sent out for the required calibration.

No.	Finding/Observation	Corrective Action
5	Multiple project preparation within the same hood area and at the same time could contribute to possible cross-contamination of samples. Improved general housekeeping and organization of laboratory work areas would help decrease possible cross-contamination of sample preparations, thereby maintaining as-received sample integrity. Also, laboratory staff are recommended to wear laboratory coats during sample preparation to avoid possible contamination from apparel.	The lab areas will be reorganized to help decrease possible cross-contamination of sample preps. Air samples will be prepared in the TEM fume hood. Water filters and other filtered samples will be prepared in a separate room. Lab coats will be worn during sample preparation to avoid cross-contamination.
6	To ensure that laboratory equipment can be traced to actual locations, especially where duplicate equipment is used, and to facilitate identification of area functions, some sort of work area identification in the form of room numbers or names is recommended.	Work area identification was implemented in the laboratory.
7	The Denton Vacuum Coater (carbon) DV502A underwent repairs last year. Per QAPP B.5.2.1.3, clean area blanks should be prepared and analyzed whenever cleaning or servicing of equipment has occurred. It was not obvious that these blanks had been prepared and analyzed.	Clean area blanks will be required whenever servicing of equipment is performed.

It was concluded that the laboratory operates under a comprehensive and appropriate QA system, has qualified personnel, has a comprehensive LIMS system, and has all necessary and appropriate equipment.

7.3 Asbestos QA/QC Sample Results

QA/QC samples were analyzed for each sample type, i.e., air (including worker), soil, settled dust, pavement (microvac), and water, as described in the QAPP. These QA/QC samples included lot blanks; field blanks; field duplicates; laboratory method blanks, replicates, duplicates, and verified counts; and interlaboratory duplicates and verified counts. The frequency of these QA/QC samples for each sample type depended on the total number of samples collected and analyzed for the type. The results of the analyses are provided in the following sections, as applicable for the different sample types.

For each matrix, in cases where two analyses have the same analytical sensitivity, variability was calculated using the following equation:

$$Variability = \frac{S1 - S2}{\sqrt{S1 + S2}} \qquad \text{\{Equation 1\}}$$

where S1 and S2 are the two total structure counts observed. This provides an estimate of the standard deviation of the difference based on a Poisson counting model.

For each matrix, in cases where the two analyses have different analytical sensitivities, variability was calculated using the following equation:

$$Variability = \frac{\left|S1 - S2 - a(S1 + S2)\right|}{b\sqrt{S1 + S2}} \qquad \text{\{Equation 2\}}$$

Where:

$$a = \frac{(MDL2 - MDL1)}{(MDL2 + MDL1)}$$

and

$$b = 2\sqrt{\frac{(MDL1 - MDL2)}{(MDL1 + MDL2)}}$$

MDL is the method detection limit (i.e., analytical sensitivity). Note that all variabilities were calculated using {Equation 1} unless otherwise noted.

The acceptance criteria for variability for the different samples matrices are presented in Table 7-3.

Table 7-3. ACCEPTED VARIABILITY

Type of Sample		Accepted Variability[1]
Air Samples	lab replicate	1.96
	lab duplicate	2.24
	Interlaboratory duplicate, field duplicate	2.50
Non-Air Samples	lab replicate	2.24
	lab duplicate	2.50

[1] For replicate air samples, for which the simple Poisson model is most directly applicable, the value 1.96 is chosen so that the criterion will flag approximately 1 replicate pair out of 20 for which the difference is due only to analytical variability, i.e., it has a "false positive" rate of 5%. For the other types of analyses, where greater natural variability is expected than indicated by a pure Poisson model, the criterion value has been increased from 1.96 in order to avoid flagging too many cases where the difference between the values is due only to normal variation, and not to any problem with either analysis. The values 2.24 and 2.50 were selected as targeting false positive rates of 2.5% (1/40) and 1.125% (1/80) for the Poisson model.

7.3.1 Air QA/QC Results

The following QA/QC samples were performed in support of the asbestos air analyses.

7.3.1.1 Lot Blanks

Lot blanks were analyzed at a frequency of two percent for each new lot of filters used. All lot blanks had non-detected asbestos concentrations at <0.0005 s/cm^3.

7.3.1.2 Field Blanks

A field blank is a filter cassette that has been transported to the field, opened for a short time (≤30 seconds), and then sent to the laboratory. All field blanks had non-detected asbestos concentrations at <10 s/mm^2.

7.3.1.3 Field Duplicates

A field duplicate is a second sample collected concurrently at the same location as the original sample (co-located). Results for field duplicates are presented in Table 7-4. These results provide information regarding the variability of the sample collection process. All field duplicate sample results for the perimeter air samples met the accepted variability criteria of 2.50.

Table 7-4. FIELD DUPLICATES FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	Duplicate Result, structures	Variability
PC-PERIMETERAIR-M03-2L-W	TEM	0	0	0
PC-PERIMETERAIR-M12-2L-W	TEM	0	0	0
BG-AIR-BG04-2L-W	TEM	0	0	0
PC-PERIMETERAIR-M08-4L-D	TEM	3	7	1.3
PC-PERIMETERAIR-M16-4L-D	TEM	0	0	0
BG-AIR-BG04-4L-D	TEM	0	0	0
PC-PERIMETERAIR-M08-8L-DEX	TEM	0	0	0
PC-PERIMETERAIR-M16-8L-DEX	TEM	0	0	0
BG-AIR-BG04-8L-DEX	TEM	0	0	0
PC-PERIMETERAIR-M03-4L-DCL	TEM	1	0	1
PC-PERIMETERAIR-M12-4L-DCL	TEM	0	3	1.7
BG-AIR-BG04-8L-DCL	TEM	0	0	0
PC-EDCASTELLANOS-2LD	TEM	0	0	0
PC-CARLOSGARDENA-2LD	TEM	0	0	0
PC-LOUISMORENO-2LDEX	TEM	1	0	0
PC-CARLOSGARDENA-2LDEX	TEM	0	0	0
PC-CARLOSGARDENA-2LDCL	TEM	0	0	0
PC-MARCOSGOMEZ-2LDCL	TEM	0	0	0

7.3.1.4 Method Blanks

All method blanks had non-detected asbestos concentrations at <10 s/mm^2.

7.3.1.5 Replicates

A replicate analysis is a second analysis of the same preparation, but not necessarily the same grid openings, by the same microscopist as the original analysis. Results for replicates are presented in Table 7-5. All replicate results for the perimeter air samples met the accepted variability criteria of 1.96.

Table 7-5. REPLICATES FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-PERIMETERAIR-M18-4L-D	TEM	0	0	0
PC-PERIMETERAIR-M08-8L-DEX	TEM	0	0	0
PC-PERIMETERAIR-M18-8L-DEX	TEM	0	0	0
PC-PERIMETERAIR-M03-4L-DCL	TEM	1	0	1
PC-PERIMETERAIR-M08-4L-DCL	TEM	0	0	0
PC-PERIMETERAIR-M12-4L-DCL-DUP	TEM	3	3	0
BG-AIR-BG04-4L-D	TEM	0	0	0
BG-AIR-BG04-8L-DEX	TEM	0	0	0
PC-EDCASTELLANOS-2LD	TEM	0	0	0
PC-CARLOSGARDENA-2LD-DUP	TEM	0	0	0
PC-WORK-D-BL	TEM	0	0	0
PC-MARCOSGOMEZ-2LDCL-DUP	TEM	0	0	0

7.3.1.6 Duplicates

A duplicate is an analysis of a second TEM grid preparation prepared from a different area of the sample filter performed by the same microscopist as the original analysis. Results for duplicates are presented in Table 7-6. All duplicates for the perimeter air samples met the accepted variability criteria of 2.24.

Table 7-6. DUPLICATES FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-PERIMETERAIR-M04-4L-D	TEM	0	0	0
PC-PERIMETERAIR-M04-8L-DEX	TEM	0	0	0
PC-PERIMETERAIR-M09-8L-DEX	TEM	1	0	1

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-PERIMETERAIR-M05-4L-DCL	TEM	0	0	0
PC-PERIMETERAIR-M13-4L-DCL	TEM	1	3	1
PC-PERIMETERAIR-M14-4L-DCL	TEM	6	7	0.3
BG-AIR-BG01-8L-DCL	TEM	0	0	0
BG-AIR-BG02-8L-DEX	TEM	0	0	0
PC- MARCOSGOMEZ -2LD	TEM	0	0	0
PC-CARLOSGARDENA-2LD	TEM	0	0	0
PC-WORK-D-BL	TEM	0	0	0
PC- CARLOSGARDENA -2LDEX	TEM	0	0	0

7.3.1.7 Verified Counts

Verified counting involves the re-examination of the same grid openings by a different microscopist. Results for verified counts are presented in Table 7-7. These results confirm the counting results of the original microscopist(s).

TABLE 7-7. VERIFIED COUNTS FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Acceptable Variability
PC-PERIMETERAIR-M08-4L-D-DUP	TEM	7	6	>80% True Positives <20% False Negatives <20%False Positives
PC-PERIMETERAIR-M18-8L-DEX	TEM	0	0	
PC-PERIMETERAIR-M10-8L-DEX	TEM	0	0	
PC-PERIMETERAIR-M03-4L-DCL	TEM	1	1	
PC-PERIMETERAIR-M17-4L-DCL	TEM	5	5	
BG-AIR-BG06-4L-D	TEM	3	3	
BG-AIR-BG04-8L-DCL	TEM	0	0	
PC-CARLOSGARDENA-2LD-DUP	TEM	0	0	
PC-LOUISMORENO-2LDEX	TEM	1	1	

7.3.1.8 Interlaboratory QA/QC

After analysis by Bureau Veritas, selected filters and grid preparations were sent to REI for analysis as an independent QA/QC check. Interlaboratory QA/QC sample analyses for the air samples included duplicates and verified counts by TEM. These results are summarized in Table

7-8 and Table 7-9. Some variability in the verified count results was observed. REI investigated the results further but no apparent cause was identified. As can be seen in Table 7-8, there was no consistent bias in the results. As shown in Table 7-9, interlaboratory duplicates met the acceptance criteria for variability of 2.50.

Table 7-8. INTERLABORATORY VERIFIED COUNTS

<table>
<tr><th>Sample ID</th><th>Method</th><th>Sample Result, structures</th><th>QA/QC Result, structures</th><th>Acceptable Variability</th></tr>
<tr><td>PC-PERIMETERAIR-M01-8L-DEX</td><td>TEM</td><td>0</td><td>0</td><td rowspan="4">>80% True Positives
<20% False Negatives
<20%False Positives</td></tr>
<tr><td>PC-PERIMETERAIR-M08-4L-D-DUP</td><td>TEM</td><td>7</td><td>14</td></tr>
<tr><td>PC-PERIMETERAIR-M03-4L-DCL</td><td>TEM</td><td>1</td><td>4</td></tr>
<tr><td>BG-AIR-BG06-4L-D</td><td>TEM</td><td>3</td><td>0</td></tr>
</table>

Table 7-9. INTERLABORATORY DUPLICATES FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-ROOFS-R06-4L-D	TEM	0	0	0
PC-PERIMETERAIR-M03-8L-DEX	TEM	0	0	0
PC-PERIMETERAIR-M08-4L-D	TEM	3	1	1
PC-PERIMETERAIR-M10-4L-D	TEM	0	3[1]	1.7
PC-PERIMETERAIR-M04-4L-DCL	TEM	0	0	0
BG-AIR-BG02-4L-D	TEM	0	0	0

[1]Average of two replicate analyses.

7.3.2 Soil QA/QC Results

The following soil QA/QC samples were analyzed in support of this study.

7.3.2.1 Method Blanks

All method blanks had non-detected asbestos concentrations at less than <10 s/mm^2.

7.3.2.2 Replicates

A replicate is an analysis from the same sample prep performed by the same analyst. Results for replicates are presented in Table 7-10. All replicates for soil samples met the acceptance criteria for variability of 2.24.

Table 7-10. REPLICATES FOR SOIL SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-SOILPOSTEX-06	TEM	3	0	1.7
PC-SOILPOSTDEMO-02	TEM	4	12	2.0
PC-SOILPOSTDEMO-06	TEM	3	6	1.0

7.3.2.3 Duplicates

A duplicate is an analysis from different sample preps performed by the same analyst. Results for duplicates are presented in Table 7-11. All duplicates for soil samples met the acceptance criteria for variability of 2.50.

Table 7-11. DUPLICATES FOR SOIL SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability[1]
PC-SOILPOSTEX-06	TEM	3	2	0.1
PC-SOILPOSTDEMO-02	TEM	4	5	0.8
PC-SOILPOSTDEMO-06	TEM	3	8	0.6
PC-SOIL-POSTDEMO-04	PLM	ND	ND	NA
BG-SOIL-03	PLM	ND	ND	NA
PC-SOILPRE-06	PLM	ND	ND	NA

ND=No asbestos detected at 0.1 percent.
NA=Not applicable
[1]Duplicate results had different analytical sensitivities. Equation 2 was used to calculate variability.

7.3.3 Settled Dust QA/QC

7.3.3.1 Field Blanks

A field blank is prepared by placing a sample container in the field, removing the lid, and immediately replacing the lid. Six field blanks were collected and analyzed. All field blanks had non-detected asbestos concentrations at <240 s/cm^2.

7.3.3.2 Field Duplicates

A field duplicate is a second sample collected concurrently at the same location as the original sample. Results for field duplicates are presented in Table 7-12. All field duplicate sample results for the settled dust samples met the accepted variability criteria of 2.50.

Table 7-12. FIELD DUPLICATES FOR SETTLED DUST SAMPLES

Sample ID	Method	Sample Result, structures	Duplicate Result, structures	Variability
PC-DUST-M02W	TEM	2	0	1.4
PC-DUST-M10W	TEM	0	0	0
BG-DUST-BG04W	TEM	0	0	0
PC-DUST-M02D	TEM	0	0	0
PC-DUST-M10D	TEM	38	46	0.9
BG-DUST-BG04D	TEM	0	0	0

7.3.3.3 Method Blanks

All method blanks had non-detected asbestos concentrations at <10 s/mm^2.

7.3.3.4 Replicates

A replicate analysis is a second analysis of the same preparation, but not necessarily the same grid openings, by the same microscopist as the original analysis. Results for replicates are presented in Table 7-13. All replicate analyses met the acceptance criteria for variability of 2.24.

Table 7-13. REPLICATES FOR SETTLED DUST SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-DUST-M11D	TEM	33	34	0.1

PC-DUST-M14D	TEM	44	45	0.1
PC-DUST-R05D	TEM	16	17	0.2
PC-DUST-M02W	TEM	2	1	0.6
PC-DUST-M18W	TEM	1	0	1
PC-DUST-W-BL	TEM	0	0	0

7.3.3.5 Duplicates

A duplicate analysis is the analysis of a second aliquot of the original dust sample aqueous suspension. Results for duplicates are presented in Table 7-14. All duplicate analyses met the acceptance criteria for variability of 2.50.

Table 7-14. DUPLICATES FOR SETTLED DUST SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
BG-DUST-BG04D	TEM	0	0	0
PC-DUST-WS03D	TEM	0	0	0
PC-DUST-M07D	TEM	38	41	0.3
PC-DUST-M11D	TEM	33	33	0
PC-DUST-M13D	TEM	52	56	0.4
PC-DUST-M18D	TEM	2	1	0.6
PC-DUST-M11W	TEM	2	3	0.5

7.3.4 Water QA/QC Results

7.3.4.1 Field Blank

A field blank is a clean sample container with approximately 800 mL of laboratory water which is opened in the field for approximately 30 seconds. Three field blank samples were collected and analyzed. All field blanks had non-detected asbestos concentrations of <0.040 MFL.

7.3.4.2 Field Duplicate

A field duplicate is a second sample collected concurrently at the same location as the original sample. Results for the field duplicates are presented in Table 7-15. Note that the QAPP did not identify any specific variability requirements for water field duplicates. As three amended water samples were collected and analyzed with no asbestos observed, the duplicate bottle may have been inadvertently contaminated. The data as a whole do not indicate a contamination issue with the amended water applied during the demolition process.

Table 7-15. FIELD DUPLICATE FOR WATER SAMPLES

Sample ID	Method	Sample Result, structures	Duplicate Result, structures	Variability
PC-HW-02	EPA 100.2	0	0	0
PC-AW-03	EPA 100.2	0	94	9.7
PC-AW-03 (analysis of second bottle for duplicate)	EPA 100.2	0	108	10.4
PC-AWSURF-03	EPA 100.2	47 (MDL = 2 MFL)	109 (MDL = 12 MFL)	2.3

7.3.4.3 Method Blank

The method blank had a non-detected asbestos concentration of <10 s/mm^2.

7.3.4.4 Replicates

A replicate analysis is a second analysis of the same preparation, but not necessarily the same grid openings, by the same microscopist as the original analysis. Results for the replicate are presented in Table 7-16. The replicate analysis met the acceptance criteria for variability of 2.24.

Table 7-16. REPLICATE FOR WATER SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-AWSURF-BL	EPA 100.2	0	0	0

7.3.4.5 Duplicates

A duplicate analysis is the analysis of a second aliquot of the original water sample. Results for the duplicate are presented in

Table 7-17. The duplicate analysis met the acceptance criteria for variability of 2.50.

Table 7-17. DUPLICATE FOR WATER SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-AWSURF-03	EPA 100.2	108	100	0.6

7.3.5 Pavement Dust QA/QC

7.3.5.1 Field Blanks

A field blank is a filter cassette that has been transported to the field, opened for a short time (≤30 seconds), and then sent to the laboratory. All field blanks had non-detected asbestos concentrations at <10 s/mm^2.

7.3.5.2 Method Blanks

The method blank analyzed with the samples had a non-detected asbestos concentration at <10 s/mm^2.

7.3.5.3 Replicates

A replicate analysis is a second analysis of the same preparation, but not necessarily the same grid openings, by the same microscopist as the original analysis. The replicate result is presented in Table 7-18. The replicate result met the acceptance criteria for variability of 2.24.

Table 7-18. REPLICATE FOR PAVEMENT SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
BG-PAVE-05-BL	TEM	0	0	0

7.3.5.4 Duplicates

A duplicate analysis is the analysis of a second aliquot of the original dust sample aqueous suspension. The result for the duplicate analysis is presented in Table 7-19. This result met the acceptance criteria for variability of 2.50.

Table 7-19. DUPLICATE FOR PAVEMENT SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
PC-SLABPOST-04-2L	TEM	39	40	0.1

7.4 Data Verification

Berger personnel reviewed all field data and laboratory data and verified the accuracy and completeness of the data reported by the laboratories. If any problems were encountered, corrective actions were taken to resolve the issue.

In addition, the EPA ORD QA Manager verified the data summary tables in this report against reported data.

7.5 QA/QC Summary

A significant number of QA/QC samples were collected and/or analyzed to support the sample results for this evaluation. The results for these samples did not indicate any significant problems with the results obtained. The data generated can be used with confidence in making project conclusions.

SECTION 8 Results

The results obtained for samples collected during the demolition are provided in this section, including process monitoring. Detailed statistical discussions are provided in SECTION 9. The cost analysis is provided in Section 8.10.

The vast majority of airborne asbestos data yielded non-detects at very low analytical sensitivities (0.0005 s/cm^3) and corresponding limits of detection (0.0015 s/cm^3). It was initially anticipated that a value of one-half the analytical sensitivity would be substituted for those values that were less than the analytical sensitivity. Further comparisons would then be made substituting additional variants below the analytical sensitivity to evaluate the effect of the substituted value. Overall, close to 80 percent of the air samples for asbestos during the AACM3 demolition were non-detect at 0.0005 s/cm^3 analytical sensitivity. All but seven were at or below the limit of detection of 0.0015 s/cm^3 (2.99 times the analytical sensitivity); the highest concentration was 0.0030 s/cm^3.

In asbestos analyses, one either sees and counts asbestos structures in a specified number of grid openings or sees none (zero). In the case of non-detects, zero asbestos structures were seen in the grid openings observed. The use of one-half the analytical sensitivity would reflect that one-half of a structure was seen, when in fact, none was seen. In an 18-sample ring, the addition of one-half structure per sample for 16 non-detects would artificially add the observance of eight asbestos structures (again when none were observed); therefore, for the purpose of descriptive statistics (mean, max and min) in the Results Section, zero was used for non-detects. For inferential statistical analyses in the Inferential Statistical Analysis Section, a different approach for estimating the mean and standard deviation was used for the non-parametric comparisons. Also, tests of significance using the "censored data" approach were considered in the Inferential Section as well (Helsel 2006).

The ISO 10312:1195 protocol suggests reporting conventions for asbestos measurements that include the 95-percentile upper and lower confidence levels for any observed asbestos structure count. Table F.1 in the ISO 10312 suggests the following reporting convention for the structure counts observed in the air samples in this study as shown in Table 8-1.

Since the lower confidence limits are less than one for structures counts from zero to three, ISO recommends the use of reporting less than the corresponding one-sided 95-percent confidence limits rather than the calculated concentration. In these AACM studies, the ISO reporting convention was not strictly adopted as it was believed that reporting the individual observed concentrations was a more comprehensive approach. With the caveats of ISO reporting methodology, any conclusions that are based upon counts less than four, as almost all the ones in this study were, should be used with some caution as there is probably no real difference between these numbers.

Table 8-1. ISO 10312:1995 REPORTING CONVENTION FOR STRUCTURE COUNTS BETWEEN ZERO AND TEN

Structure Count	95-% Confidence Lower Limit	95-% Confidence Upper Limit
0	0	3.689
1	0.025	5.572
2	0.242	7.225
3	0.619	8.767
4	1.090	10.242
5	1.624	11.669
6	2.202	13.060
7	2.814	14.423
8	3.454	15.764
9	4.115	17.085
10	4.795	18.391

To summarize:

- For descriptive statistics, a value of zero was substituted for non-detects.
- In cases where there were less than five percent censored data and substituting one-half the detection limit would not affect the conclusions of the inferential test, the parametric methods proposed in the QAPP were employed, unless the assumptions of the parametric test were not met.
- In cases where the censored values ranged between five and 85 percent and there were multiple detection limits, nonparametric methods based on multiple detection limits were employed when appropriate.
- Above 85-percent censoring no descriptive statistics were calculated.
- When the high level of censoring prohibited inferential analyses using the asbestos concentrations, the data were described using the binomial distribution where the random variable was the probability of a censored value.
- In cases where there were greater than 90-percent non-detect data for either method, no statistical analyses were conducted.

8.1 Demolition Activities

There was full compliance with all applicable OSHA requirements and an OSHA inspector was present during the demolition.

The demolition activities were not as efficient as anticipated. Several problems were encountered:

- Administrative delays did not allow for adequate contractor preparation.
- Other concerns necessitated a last-minute contractor switch.
- An insufficient supply of roll-offs delayed the effort.
- Carpet left in place during demolition hampered debris loading.
- Final cleaning (decon) of the track-hoe was a tedious and laborious process.

8.2 Air

Table 8-2 presents the descriptive statistics for the airborne asbestos concentrations measured during all phases of the demolition of the popcorn building:

- pre-wetting,
- demolition and debris removal,
- excavation (soil removal) and
- cleaning of the concrete slab, track-hoe, and pavement.

The individual sample results are contained in Table 13-3 through Table 13-6 in the Appendix. The individual asbestos concentrations are illustrated in Figure 8-1.

In each grouping of samples presented in Figure 8-1, the samples are in numerical order in the manner in which the samplers were placed around the buildings (Figure 5-3). That is, the first sample in each group of 18 corresponded to the location on the left-front corner of the building and then were numbered in a clockwise fashion around the structure. The roll-offs entered the containment area between samplers 13 and 14 and were loaded along the front of the building (samplers 15 through 18 in each grouping). Accumulated water on the pavement was designed to be pumped from a sump constructed on the pavement next to sampler 16, which was the low point for drainage from the paved area, but very little water accumulated there.

Visually, there does not appear to be any correlation between sample location and the small concentrations of asbestos observed in the air samplers during all phases except for the cleaning/decon phase where small amounts of asbestos were detected generally adjacent to the pavement and in the generally downwind direction. The wind was consistently blowing from the front left to the rear right (from the south-southwest) of the building.

All of the airborne asbestos concentrations observed were *near or below the limit of detection, which is 0.0015 s/cm^3*. Only seven samples exceeded the limit of detection, with the highest total asbestos concentration being 0.0030 s/cm^3.

Statistically, there was no significant difference observed between the asbestos concentrations during all phases of AACM3 (pre-wetting, demolition/debris removal, excavation, and cleanup,decon) and the background asbestos concentrations (Section 9.2.1.1.5). The statistical analysis concluded *one would fail to reject the null hypothesis*, where the null hypothesis was that there was no difference in the two distributions.

TABLE 8-2. AIRBORNE ASBESTOS (TEM) DURING DEMOLITION OF THE POPCORN BUILDING

Sample Location (Position and Height)		Total Asbestos					PCME Asbestos				
		n/N[a]	Structures Counted, Total/group, Max/filter	Mean[b] (s/cm^3)	Min (s/cm^3)	Max (s/cm^3)	n/N[a]	Structures Counted, Total/group, Max/filter	Mean[b] (s/cm^3)	Min (s/cm^3)	Max (s/cm^3)
Pre-Wetting the Night Before Demolition											
Background	5-ft	1/6	3 total 3 max	0.00023	0	0.0014	0/6	0 total 0 max	0	0	0
Ring	10-ft	0/18	0 total 0 max	0	0	0	0/18	0 total 0 max	0	0	0
Demolition and Debris Removal											
Background	5-ft	1/6	3 total 3 max	0.00023	0	0.0014	0/6	0 total 0 max	0	0	0
Ring	10-ft	4/18	9 total 4 max	0.00024	0	0.0019	0/18	0 total 0 max	0	0	0
Balconies	15-ft	2/6	8 total 7 max	0.00065	0	0.0034		0 total 0 max	0	0	0
Top of Wall	25-ft	0/3	0 total 0 max	0	0	0		0 total 0 max	0	0	0
Across Street	5-ft	0/3	0 total 0 max	0	0	0		0 total 0 max	0	0	0
Excavation (Soil Removal)											
Background	5-ft	0/6	0 total 0 max	0	0	0	0/6	0 total 0 max	0	0	0
Ring	10-ft	1/18	1 total 1 max	0.00003	0	0.00048	0/18	0 total 0 max	0	0	0
Cleaning/ Equipment Decon											
Background	5-ft	0/6	0 total 0 max	0	0	0	0/6	0 total 0 max	0	0	0
Ring	10-ft	8/18	29 total 6 max	0.00079	0	0.0030	0/18	0 total 0 max	0	0	0

[a] Denotes number of samples at or above analytical sensitivity/total number of samples. The analytical sensitivity ranged from 0.00047 to 0.00050 s/cm^3. The ISO limit of detection for asbestos is equal to three times the analytical sensitivity (<0.0015 s/cm^3) for TEM.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

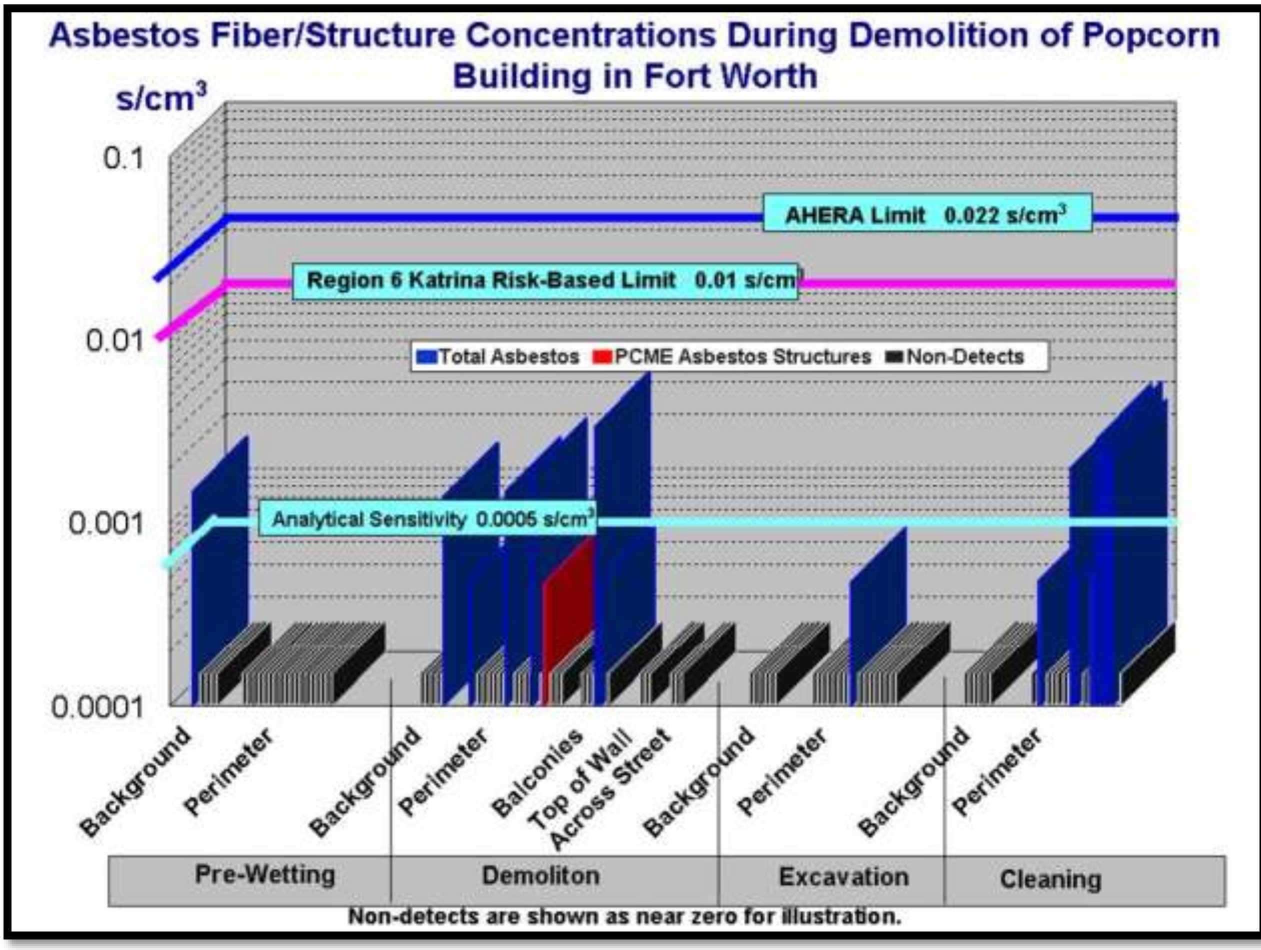

Figure 8-1. Airborne asbestos concentrations (TEM) for AACM3.

8.2.1 Pre-Wetting Phase

The pre-wetting phase began the evening before the demolition when the interior of the popcorn building was wetted with amended water. This phase was monitored at the request of the Texas State Department of Health Services to provide complete monitoring of the entire activity. There was no asbestos detected in any of the perimeter samplers; however small amounts of asbestos were detected in one of the background samplers during this period.

Statistically, there was no significant difference observed between the asbestos concentrations during the pre-wetting phase and the background asbestos concentrations (Section 9.1.1.1). The statistical analysis concluded *there is no difference in the probability of observing a censored value (*non-detect*) in the AACM and BKGD pre-wetting data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the pre-wetting process.*

8.2.2 Demolition and Debris Removal Phase

During the actual demolition and debris removal phase, approximately twenty percent (4/18 samples) showed asbestos concentrations at or above the analytical sensitivity (Table 8-2). The largest total asbestos concentration observed in the perimeter ring during the demolition was 0.0019 s/cm^3. Importantly, no PCME-size asbestos structures were observed. Again, small amounts of asbestos were detected in one of the background samplers during this period (0.0014 s/cm^3).

Two of the six samplers located on the adjacent balconies on both the right and left sides of the building detected small quantities of asbestos, with the largest concentration being 0.0034 s/cm^3. Both of these detections were on the downwind (right) side of the building.

None of the three samplers located on top of the barrier wall in front of Boca Raton Boulevard and none of the three samplers placed in front of the occupied apartment complex across Boca Raton Boulevard detected asbestos.

Statistically, there was no significant difference observed between the asbestos concentrations during the demolition and debris removal phase and the background asbestos concentrations (Section 9.1.1.2). The statistical analysis concluded *there is no difference in the probability of observing a censored value in the AACM and BKGD demolition data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the demolition process.*

8.2.3 Excavation (Soil Removal) Phase

Only one of 18 perimeter samplers detected asbestos (0.00048 s/cm^3) as shown in Table 8-2 and Figure 8-1. No PCME- size structures were observed and no asbestos was detected in any background samples.

Statistically, there was no significant difference observed between the asbestos concentrations during the excavation phase and the background asbestos concentrations (Section 9.2.1.1.3). The statistical analysis concluded *there is no difference in the probability of observing a censored value in the AACM and BKGD excavation data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the excavation process.*

8.2.4 Cleaning and Equipment Decon Phase

Eight of the eighteen samplers detected asbestos during the cleaning and equipment decon phase, with the largest concentration being 0.0030 s/cm^3. No PCME- size structures were observed and no asbestos was detected in any background samples. As seen in Figure 8-1 and Figure 5-3, most of the samplers that detected asbestos were located along the sides of the pavement in front of the building.

Statistically, there was no significant difference observed between the asbestos concentrations during the cleanup/decon phase and the background asbestos concentrations (Section 9.1.1.4). The statistical analysis concluded *there is no difference in the probability of observing a censored value in the AACM and BKGD clean-up data. Due to the high level of censoring, an* *inferential test for AACM and BKGD mean differences could not be conducted for the clean-up process.*

8.2.5 PCM Fiber Concentrations

The Phase Contrast Microscopy results for all phases of the popcorn building demolition are shown in Figure 8-2 and are presented in Table 13-3 through Table 13-6 of the Appendix. While PCM values do not distinguish between asbestos and a variety of other fibers, they are indicative of the effectiveness of the wetting controls as to overall fiber release, and in AACM3 they clearly demonstrate that the filters are capturing fibers; fortunately most are not asbestos and they may not be emanating from the demolition activity. There is a high background fiber concentration in the vicinity of the popcorn building. Visually, there appears to be no difference in the background fiber concentrations and those in the perimeter ring.

Statistically, there was no significant difference observed between the fiber concentrations during the cleanup/decon phase and the background asbestos concentrations (Section 9.2.1.1.5). The statistical analysis concluded *one would fail to reject the null hypothesis of no difference in the mean concentration of total fibers observed for AACM and BKGD for the combined data.*

Also, no statistically significant differences in fiber concentrations were observed in any of the unit processes (pre-wetting, demolition/debris removal, excavation, and cleanup/decon) as compared to background (section 9.1.1.1 through section 9.1.1.4).

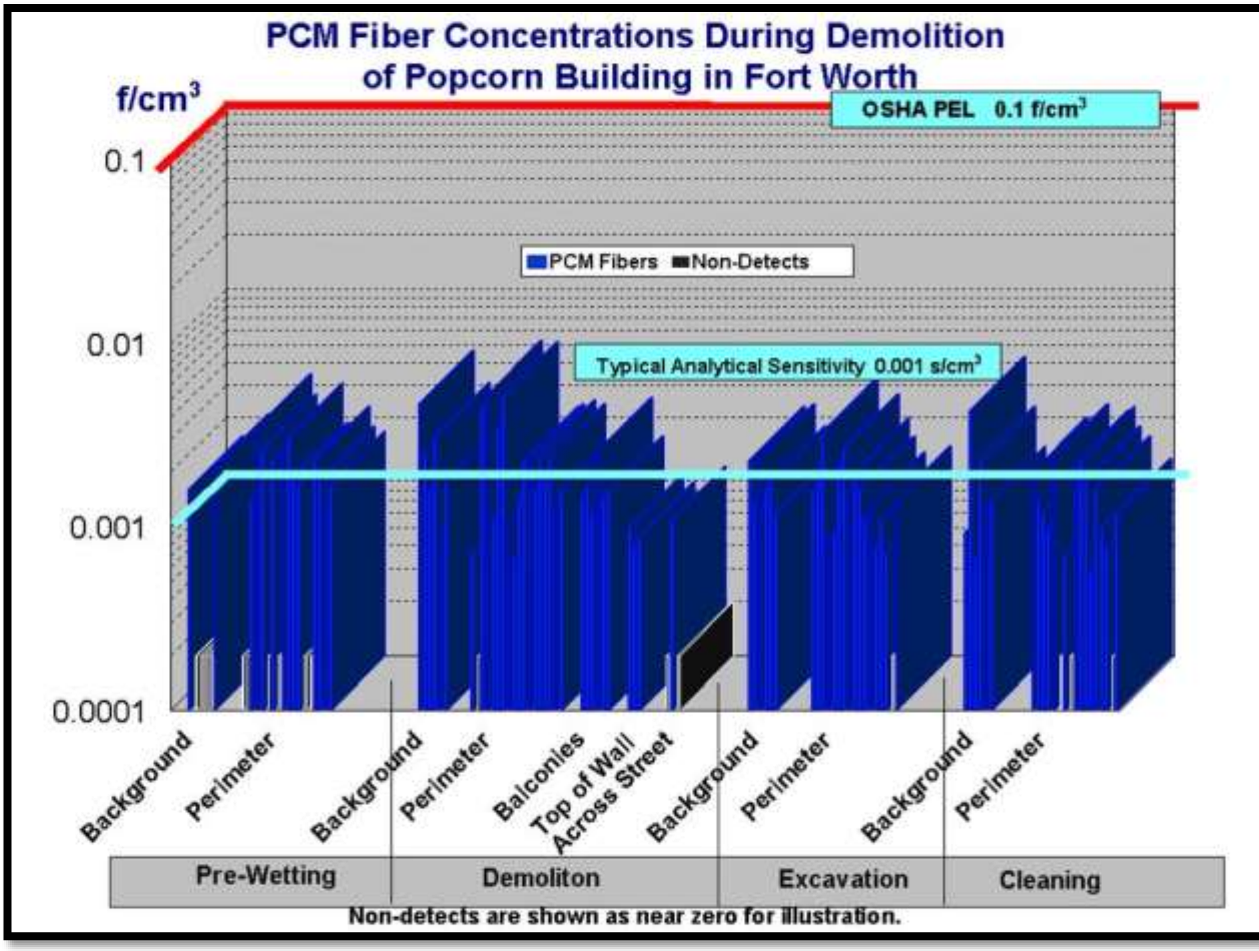

Figure 8-2. PCM fiber concentrations for the popcorn building demolition.

8.2.6 Perimeter Air Summary

All of the airborne asbestos concentrations observed were *near or below the limit of detection, which is 0.0015 s/cm^3*. Only seven samples exceeded the limit of detection, with the highest total asbestos concentration being 0.0030 s/cm^3. These concentrations are significantly less than AHERA (40 CFR §763) TEM clearance criterion (0.022 s/cm^3). No PCME-size asbestos fibers were observed, so the concentrations are far below the risk-based level (0.009 s/cm^3) established by EPA for occupancy of residential structures surrounding the World Trade Center Complex and the 0.01 s/cm^3 PCME risk-based value established by EPA for Hurricane Katrina recovery (EPA 2005). The highest concentration observed (0.0030 s/cm^3) was about half the average ambient air concentrations (0.0057 s/cm^3) reported by the California Air Resources Board for Eldorado County between 1998 and 2001 (State of California 2003). These data (Figure 8-1) demonstrate that the AACM3 demolition protocol was effective in controlling the release of airborne asbestos.

Statistically, there was no significant difference observed between the asbestos concentrations during all phases of AACM3 (pre-wetting, demolition/debris removal, excavation, and cleanup/decon) and the background asbestos concentrations (Section 9.2.1.1.5). The statistical analysis concluded *one would fail to reject the null hypothesis* (that the concentrations were equal).

8.3 Visible Emissions

EPA staff observed no visible emissions during the entire AACM demolition process.

8.4 Settled Dust

Table 8-3 presents the descriptive statistics for the settled dust samples collected during demolition of the popcorn building. The individual sample results are contained in Table 13-8 and are illustrated in Figure 8-3. The results are reported as number of asbestos structures per unit area of surface (s/cm^2). A calculated deposition rate in asbestos structures per unit area per time (s/cm^2/hour) is also presented.

TABLE 8-3. ASBESTOS (TEM) IN SETTLED DUST DURING DEMOLITION OF POPCORN BUILDING

Sample Description	Total Asbestos Loading, s/cm^2				Asbestos Deposition Rate, s/cm^2/hour		
	n/N[a]	Mean[b]	Min	Max	Mean[b]	Min	Max
Pre-Demolition Wetting							
Background	2/6	184,000	0	1,100,000	12,800	0	76,000
Perimeter	3/18	66	0	480	5	0	31
Demolition, Debris Removal, Excavation, and Cleaning							
Background	0/6	0	0	0	0	0	0
Perimeter	16/18	9,700	0	45,000	346	0	1,600
Adjacent Balconies	4/6	2,400	0	5,100	22	0	392
Top of Wall	0/3	0	0	0	0	0	0
Woodstock Apt	0/3	0	0	0	0	0	0

[a] Denotes number of samples at or above analytical sensitivity/total number of samples. The analytical sensitivity was 240 s/cm^2.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

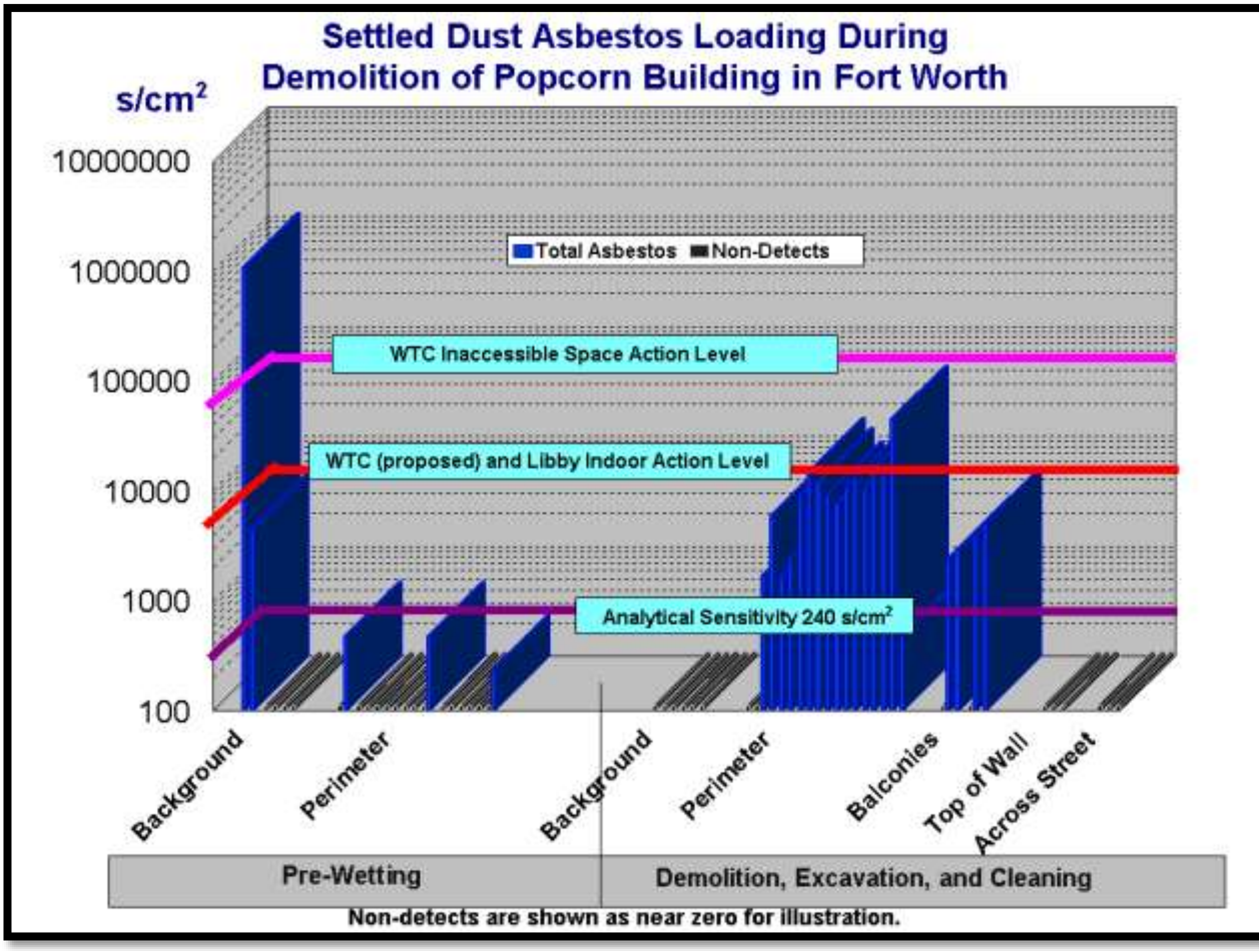

Figure 8-3. Settled dust loadings from the popcorn building demolition.

Although the following information is not directly applicable to this project, it is provided as a point of reference for settled dust data interpretation. The draft report from the Contaminants of Potential Concern Committee of the World Trade Center Indoor Air Task Force Working Group discussed dust analyses and the significance of the results. This report (USEPA 2005) suggests the following action levels to initiate cleanup for residential structures:

- 5,000 s/cm^2 for living spaces and
- 50,000 s/cm^2 for inaccessible spaces.

The report goes on to reference that the cleanup action level at Libby Montana Superfund Site is 5,000 s/cm^2 in generally accessible areas.

As shown in Figure 8-3, the settled dust results were highly variable. One of the six background dust samplers located many hundred feet upwind had a high asbestos loading (1,100,000 s/cm^2) during the pre-wetting and overnight monitoring phase. This sampler was co-located with the five other background samplers, four of which had no detectable asbestos. There was considerably more asbestos measured in the settled dust than in the co-located air samples. There appeared to be more asbestos in the perimeter dust samples than in the ones located slightly higher on the balconies. Two of the three settled dust samples on each the right (downwind) and left balconies had asbestos in the settled dust; this is in contrast to the air samples, which only had detects on the right (downwind) balcony.

The statistical analysis (section 9.2.2) for settled dust was complicated by the one extremely large value (1,100,000 s/cm^2) observed in one background sample during the pre-wetting phase. If that sample is treated as an outlier, then the statistical analysis indicated that the null hypothesis (that the loadings were equal) was rejected and there was a difference between the perimeter settled dust asbestos loading for the entire AACM process and the background settled dust asbestos loading. Conversely, if the high value is included, and there is no discernable reason to reject it, then the statistical test barely fails to reject the null hypothesis. The statistical conclusion was (section 9.2.2.1.3) that "s*ince there is no assignable cause for the outlier and the results from the inferential tests at the 0.05 level of significance are inconclusive no inferences can be made regarding the asbestos concentrations in the settled dust of the AACM and BKGD data observed during the combined process of pre-wetting and demolition/excavation/clean-up."* Intuitively, it is likely that there was an increase in the settled dust asbestos loadings as a result of the AACM3.

When the individual unit operations (in this case pre-wetting and a combination of demolition/excavation/cleanup) are compared to background, there was no increase in the settled dust loading as a result of the pre-wetting activity as compared to background. During the demolition/excavation/cleanup phase, however, there does appear to be an increase, The statistical analysis (section 9.2.2.1.2) of this phase concluded that *although due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the demolition/excavation/clean-up process, it appears the mean concentration of asbestos in the AACM settled dust (9,802 s/cm^2) is greater than BKGD (all concentrations are below 240 s/cm^2).*

8.5 Pavement Surface

Individual pavement surface data are presented in Table 8-4 and Table 13-7 of the appendix and are shown graphically in Figure 8-4. All background, pre-demolition, and post demolition pavement samples were non-detect at a 730 to 1,000 s/cm^2 analytical sensitivity. There were no PCME-size asbestos structures observed in the pavement samples.

The statistical analysis (section 9.2.3.1) concluded that *based on the empirical data, one would conclude there is no evidence to suggest the asbestos concentrations on the pre-demolition versus post-demolition pavement and on the pre-demolition versus background pavement are different.*

TABLE 8-4. PAVEMENT SURFACE SAMPLES

Sample Description	Total Asbestos Loading, s/cm²			
	n/N[a]	Mean[b]	Min	Max
Site Assessment Pre-Survey				
Site Assessment Pre-Survey	6/7	15,000	0	54000
AACM3 Demolition				
Background	0/4	0	0	0
Pre-Demolition	0/4	0	0	0
Post-Cleanup	0/3	0	0	0

[a] Denotes number of samples at or above analytical sensitivity/total number of samples. The analytical sensitivity ranged from 730 to 11,000 s/cm^2.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

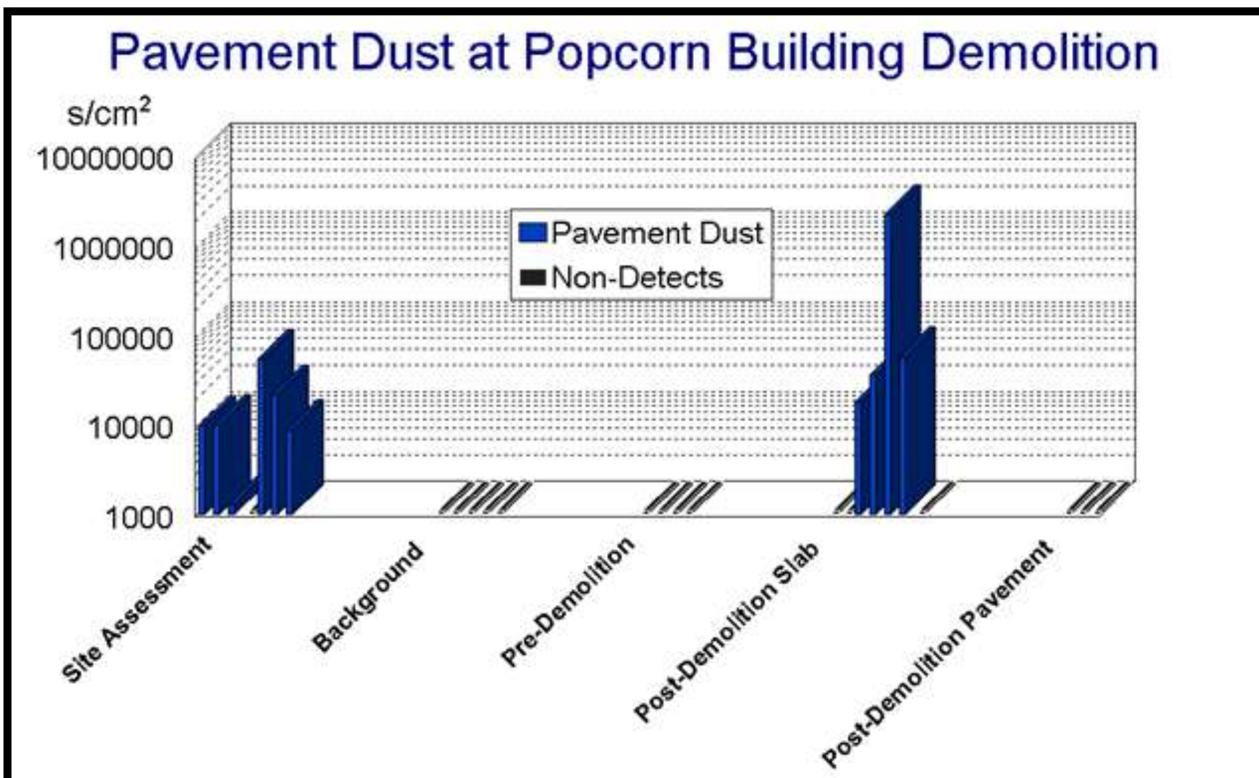

Figure 8-4. Pavement surface sampling results from the popcorn building demolition.

Six samples were taken on the concrete slab building foundation, which was later removed. Two of the six were non-detect; the other four ranged from a low of non-detect to a high of 1,100,000 s/cm^2, with an overall mean near 190,000 s/cm^2. Although the specific cause cannot be determined, this was attributed to possible recontamination from the exterior of the hoses.

8.6 Water

Table 8-5 shows the volume of water used during the demolition of the popcorn building.

The amended water was applied at the nominal concentration of one percent wetting agent as verified by the conductivity sampling using two firehoses operating at approximately 15 gpm each. Although diversion ditches had been constructed and lined with plastic, very little water accumulated in those ditches and even less in the plastic lining the ditches. While there was provision for capture, storage, and filtration of the water from the ditches, this was not required because such little water accumulated here. Only minimal water accumulated along the pavement curb in the front of the building, where the roll-offs were loaded. This volume was so small that at the end of the cleanup, only 50 gallons were required to be captured and returned to the last roll-off for co-disposal with the excavated soil as asbestos-containing waste.

Overall, about 9500 gallons of water were applied during the entire process, from pre-wetting, demolition/debris disposal, excavation (soil removal), and ultimately equipment decon and final cleaning. Approximately 100 gallons of the NF-3000 wetting agent were used during the study to achieve the one-percent amended water concentration. Virtually 100-percent of the water applied either left the site with the building debris or with the excavated soil. It is possible that some water percolated below the layer that was excavated, but it was not apparent during the excavation.

Table 8-5. WATER USAGE DURING THE POPCORN BUILDING DEMOLITION

Phase of Demolition	Hydrant Meter Reading (100 ft^3)		Source Water Usage, Gallons
	Start	Stop	
Wetting through Cleanup	1145.4	1158.1	9500

Table 8-6 presents the asbestos analysis of the source water with and without the wetting agent, as well as pooled surface water resulting from the demolitions. The analytical results indicate that pooled surface water collected from inside the berm contained asbestos.

The only current EPA regulations on asbestos in water are the drinking water standards. The U.S. EPA National Primary Drinking Water Standards (40CFR 141.51, 2002) mandates a limit for the concentration of asbestos fibers (longer than ten microns) at seven million fibers per liter; i.e., the Maximum Contaminant Level (MCL) for asbestos in drinking water. Although the Federal Drinking Water Standard is clearly not applicable in this situation, this discussion is provided to establish a relative frame of reference for the asbestos concentrations observed in the water phase. The maximum total (>10µ) asbestos concentration in the pooled surface water was about twice the EPA drinking water standard. This is not unexpected since the AACM anticipates transfer of some asbestos to the water, but the water is captured and filtered before ultimate disposal. Where soil exists around the structure, the water permeates into the soil transferring the asbestos into the soil matrix; therefore the AACM requires the removal of some soil from the site at the completion of the demolition. Neither water capture or soil removal are required with the existing NESHAP process.

Table 8-6. ASBESTOS (TEM) IN WATER FROM THE POPCORN BUILDING DEMOLITION

Sample Description	Asbestos Concentration, million s/L							
	>10µ				Total			
	n/N[a]	Mean[b]	Min	Max	n/N[a]	Mean[b]	Min	Max
Source Hydrant	0/2	0	0	0	0/2	0	0	0
Applied Amended Water	0/3	0	0	0	0/3	0	0	0
Surface Water	4/4	9.3	2	16	4/4	62	22	94

[a] Denotes number of samples at or above analytical sensitivity/total number of samples.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

8.7 Worker

Workers were monitored during all phases of the study. Individual sample results are presented in Table 13-10 and Table 13-11. Table 8-7 presents the descriptive statistics for the personal breathing zone concentrations of asbestos (TEM) and total fibers (PCM) measured during demolition of the popcorn building.

The demolition worker samples were analyzed by TEM and by PCM (Table 8-7). About one-third of the worker samples were classed as overloaded by the laboratory, but were analyzed by the direct method. All but one of the worker breathing zone samples were non-detect for total asbestos (all asbestos structures >0.5 microns in length and ≥3:1 aspect ratio) at analytical sensitivities between 0.003 and 0.001 s/cm^3. Overall, none of the worker samples showed detectable PCME asbestos structures (>5 microns in length and ≥3:1 aspect ratio) during the demolitions. The single worker sample that showed detectable asbestos had one structure on the area of the filter that was counted. Time-weighted averages, based upon the PCM fiber counts, were all well below the OSHA Personal Exposure Limit (PEL) of 0.1 f/cm^3.

Table 8-7. PERSONAL BREATHING ZONE CONCENTRATIONS OF ASBESTOS (TEM) AND TOTAL FIBERS (PCM) DURING DEMOLITION OF THE POPCORN BUILDING

Workers	Total Asbestos, s/cm^3				PCME Asbestos, s/cm^3				Total Fibers, f/cm^3			
	n/N[a]	Mean [b]	Min	Max	n/N[a]	Mean [b]	Min	Max	n/N	Mean[b]	Min	Max/ Max TWA
Pre-Wetting												
All	0/2	0	0	0	0/6	0	0	0	2/2	0.025	0.013	0.037/ (0.002)
Demolition/ Debris Disposal												
All	0/6	0	0	0	0/6	0	0	0	6/6	0.009	0.002	0.015/ (0.003)
Excavation (Soil Removal)												
All	1/5	0.0008	0	0.005	0/5	0	0	0	5/5	0.014	0.008	0.018/ (0.0003)
Cleaning/ Equipment Decon												
All	0/4	0	0	0	0/4	0	0	0	4/4	0.013	0.007	0.020/ (0.0003)

[a] Denotes number of samples at or above analytical sensitivity/total number of samples.
The analytical sensitivity was 0.005 s/cm^3 for TEM and 0.001 f/cm^3 for PCM. The ISO limit of detection for asbestos is equal to three times the analytical sensitivity (<0.015 s/cm^3) for TEM.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

In seventeen worker samples taken over the course of the AACM3 demolition of the popcorn building, only one sample had detectable asbestos and that one had a single fiber detected. The extremely low worker breathing zone asbestos concentrations seen in AACM3 offer a significant advantage for the AACM technology.

8.8 Soil

Each of the composite samples was dried in the laboratory and homogenized. The individual sampling results are contained in Table 13-9 of the Appendix.

8.8.1 Total Asbestos

The soil was analyzed for asbestos by PLM point counting and TEM. Table 8-8 presents the descriptive statistics for the asbestos analyses (PLM and TEM) for the soil. The individual sample results are contained in Table 13-9 of the Appendix.

The PLM results for the AACM3 soil fraction from all samples were non-detect at an analytical sensitivity of 0.1 percent, as shown in Table 8-8 and illustrated in Figure 8-5.

The individual TEM asbestos concentrations are illustrated in Figure 8-5 and the mean TEM concentrations are illustrated in Figure 8-6. With increased sensitivity by this method, the variability is apparent. This variability represents the sum of variabilities from both the sampling process (including heterogeneity of the site) and the analytical process. It is very difficult to generate a representative, consistent filter loading for TEM analysis, as a very small portion of the sample must be used to prevent overloading.

Table 8-8. ASBESTOS (PLM AND TEM) RESULTS IN SOIL

% of Sample by wt.	PLM – Point Count Asbestos (%)				TEM Asbestos (10^6 Structures/g)			
Mean	n/N [a]	Mean [b]	Minimum	Maximum	n/N [a]	Mean [b]	Minimum	Maximum
Background								
99.1	0/4	0	0	0	2/4	3.7	0	13.6
Pre-Demolition								
95.8	0/6	0	0	0	4/6	1.3	0	3.6
Post-Demolition								
97.9	0/6	0	0	0	5/6	6.1	0	19.1
Post-Excavation								
94.6	0/6	0	0	0	1/6	0.02	0	3.7

[a] Denotes number of samples at or above analytical sensitivity/total number of samples.
The analytical sensitivity for PLM point count was 0.1 percent. The analytical sensitivity for TEM ranged from $1.1x10^6$ to $1.3x10^6$ structures/g.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

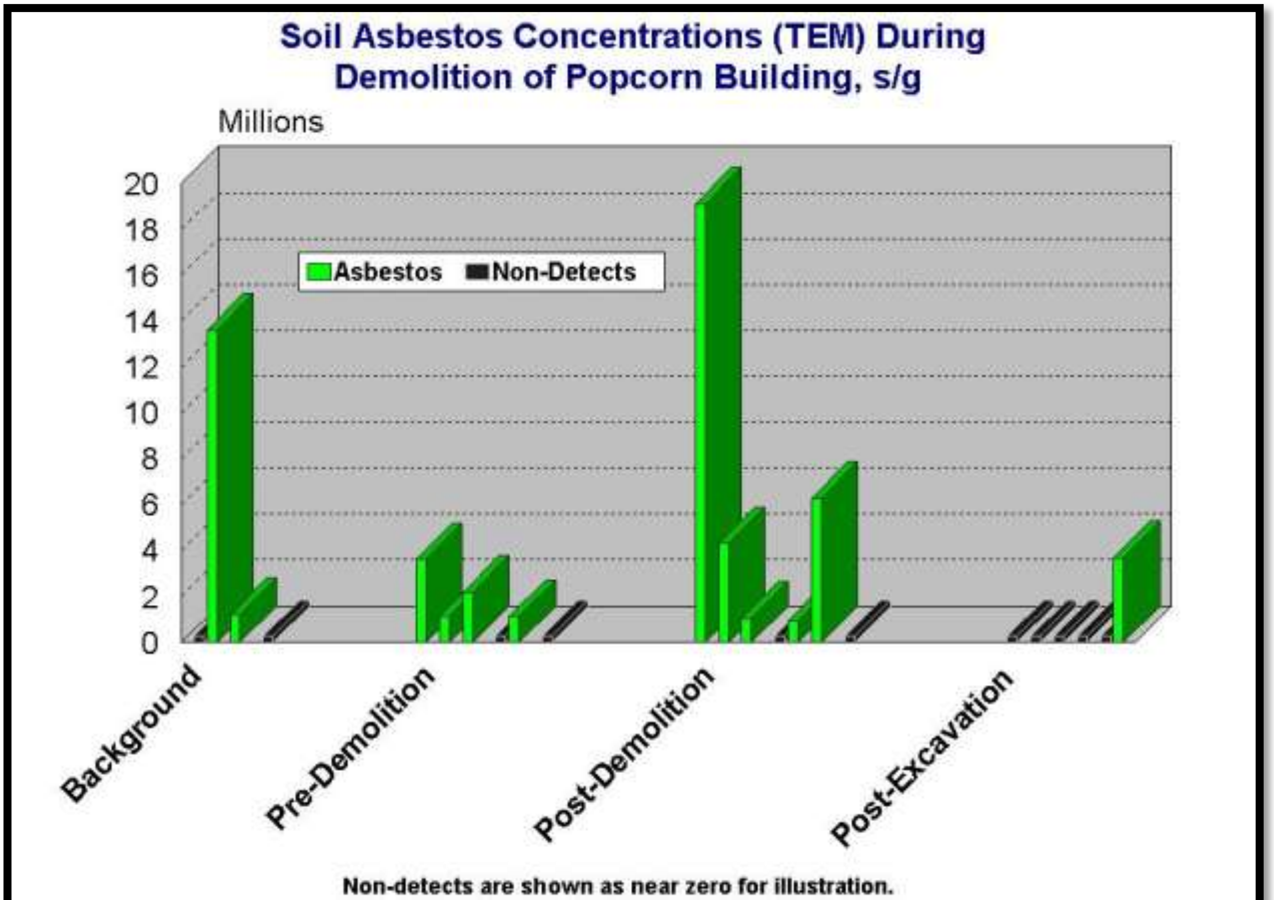

Figure 8-5. Soil asbestos concentrations by TEM for the demolition.

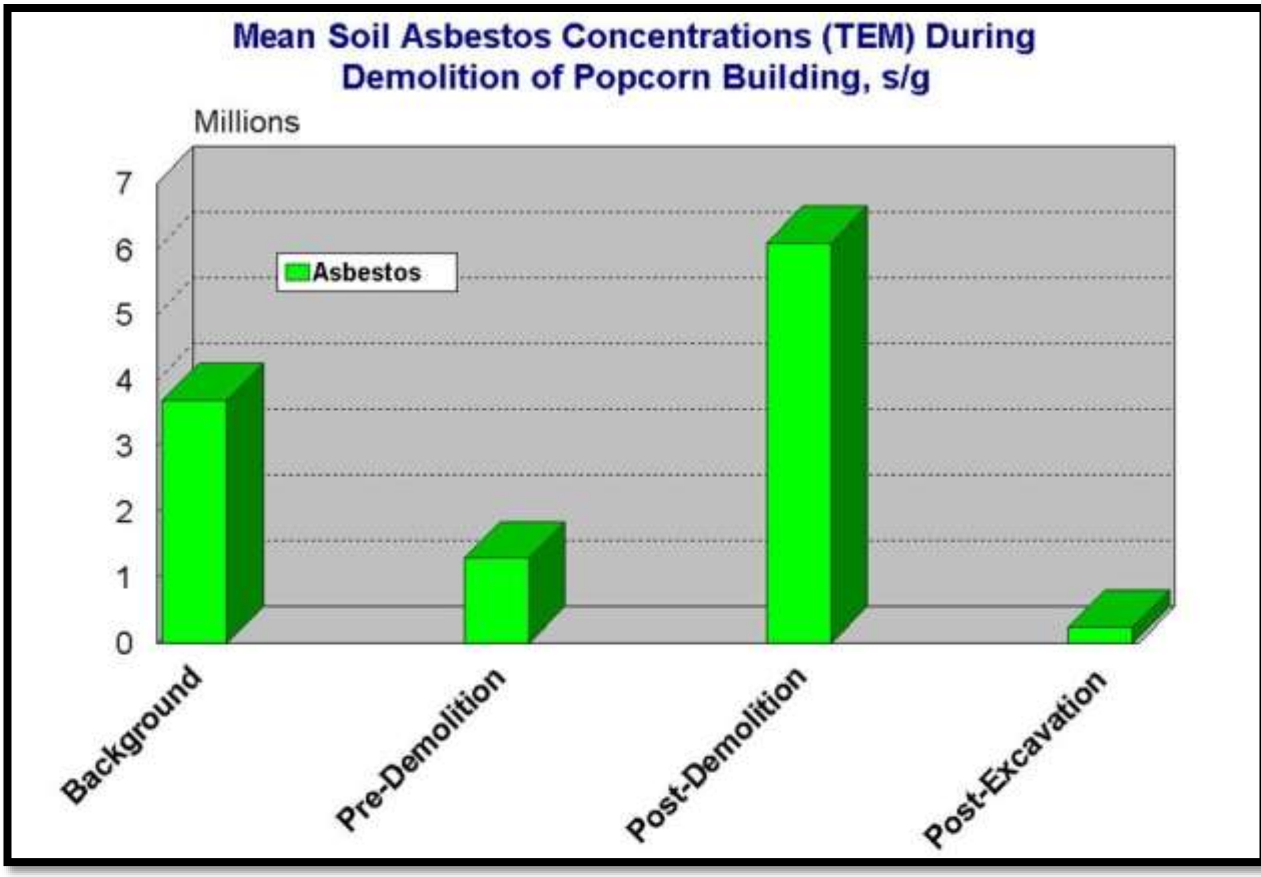

Figure 8-6. Mean soil samples asbestos concentrations during AACM3 demolition.

The statistical analyses (section 9.2.3.2) showed that the pre-demolition and post-demolition soil asbestos concentrations were not different, concluding that *one would fail to reject the null hypothesis (that the post-demolition and pre-demolition concentrations were equal).* In Figure 8-6, however, the mean for the post-demolition soil asbestos concentration appears larger than the pre-demolition mean, which is logical. Conversely, the smallest value of all is the post-excavation mean soil asbestos concentration.

8.9 Time

The demolition of AACM3 required three full days plus a day for the slab removal and re-grading; it should have been completed in two full days plus a day for slab removal and re-grading for a total of three days.

Estimates of time required to perform the abatement were typically five days, because of the surface area required to be removed and because scaffolding would have been required to access a great deal of the ceiling. After the five days of abatement, demolition and debris removal would have required one additional day. Another additional day would have been required for the slab removal and re-grading operations for a total of seven days.

8.10 Cost

The costs associated with the building demolition were documented and analyzed to clearly and transparently assign the appropriate cost elements. Costs attributable to conducting the research effort were excluded from these demolition costs. Ultimately, the total costs per cost element were obtained and summarized.

Specifically, the demolition costs presented include the cost of all labor, materials, and supplies to perform the demolition of the AACM building. Specifically, these costs included:

- pre-demolition wetting of the structure,
- demolition of the structure using asbestos-trained workers and NESHAP-trained observers,
- personal protective equipment,
- transportation and disposal of all construction debris as asbestos-containing waste at a licensed landfill,
- post-demolition excavation of soil,
- transportation and disposal of soil as asbestos-containing waste at a licensed landfill, decon of equipment and work areas following demolition activities, and
- Cost of later removal and disposal of the concrete slab.

8.10.1 Methodology

A total cost accounting for the demolition effort was performed. In order to provide as true a cost as possible, research project related sampling effort (labor and equipment), site preparation costs related to the sampling effort, redundant equipment onsite due to the research effort that would not normally be required for a typical demolition project, other redundancies (excess workers), and down time of demolition equipment and personnel due to delays caused by non-demolition related items (e.g., work delay due to unacceptable weather conditions for the monitoring required by the research effort) were excluded from the demolition costs. Specific cost items excluded from the presented demolition costs were:

- Project planning and QAPP development.

- Sampling related to the research effort that would not normally be required.

- Site preparation such as removal of shrubs, construction of screen wall, and street barricades.

- Redundant capabilities not typical on demolition projects.

- Downtime due to weather delays.

- Onsite security for sampling equipment.

- Other miscellaneous costs not directly related to the demolition.

Invoices from contractors and material purchases, time sheets, trucking invoices, and waste disposal manifest were used to develop the demolition costs. As such, the costs were the actual costs incurred during the demolition and reflected labor and equipment rates available in Fort Worth, Texas. It should be noted that construction crew standby costs resulting from weather-related delays were excluded from the presented demolition costs. For similar demolition activities performed in other locations, the cost may increase or decrease depending on local conditions and the competitiveness of firms offering these services.

8.10.2 Cost Items

The following sections provide the details of the individual cost items that are coalesced and summarized in Table 8-9, which is located at the end of this section.

8.10.2.1 Pre-Demolition Asbestos Compliance Inspection

A pre-demolition asbestos compliance inspection was required and performed by Industrial Hygiene and Safety Technology, Inc. (IHST) a Texas Department of State Health Services Licensed Asbestos Consultant Agency. The cost was approximately $1200 and included the collection and analysis of eighteen bulk samples.

8.10.2.2 Demolition

Demolition costs include the cost of the heavy equipment and labor. The track-hoe was billed at a rate of $110/hour including the operator for a total of 20.5 hours. Site personnel including workers and supervisor were billed at a rate of $45/hour and $65/hour respectively and are based on the reported hours on invoices. Total hours worked can be broken down to 39.25 hours of supervisor time and 126 hours of worker time. Labor hours and equipment charges during delays caused by weather and the research sampling effort are not included.

Pre-wetting was performed at approximately 5:00 P.M. on a Sunday, December 16, 2007. Actual building demolition and debris loading was performed on Monday, December 17, 2007. Soil removal was performed on Tuesday, December 18, 2007. Site cleanup and heavy equipment decontamination was performed part of the day on Tuesday, December 18, 2007 and Wednesday, December 19, 2007.

8.10.2.3 Water and Amended Water Surfactant

Water containing a surfactant was used during the demolition to control dust and prevent the release of asbestos into the air. Water was supplied through a hydrant operated by the City of Fort Worth. Hydrant charges over the test program were $50.69. Water was billed at $1.97 per 100 cubic feet (CCF) plus $15.67 service charge and a $10.00 activation fee. A total of 12.7 CCF were used during the project. The cost of the wetting agent was based on the approximately 100 gallons of surfactant used and was about $1,240 at the $12.40 per gallon cost. Other wetting agents may work as well and cost considerably less.

8.10.2.4 Roll-off Box Rental and Transportation Costs

Roll-off trucks used in this effort were owned and operated by Eagle Construction and Environmental Services, L.P. The billing rate for the truck and truck driver was $80/hour. A total of 100 hours of roll-off truck operation was billed as part of the AACM3. By using roll-off containers a truck and truck driver was required on-site to position roll-off containers during demolition, demolition debris loading and soil removal. Overall, there were 21 roll-off boxes for disposal; 13 with debris, six with mostly soil, and two with debris/soil mixtures. All of these went as asbestos-containing wastes. Roll-off boxes were billed at $16/day per box for a total of 68 box days.

8.10.2.5 Disposal Costs

The disposal costs for asbestos waste including the soil were based upon invoices from the Waste Management – Lewisville landfill facility. The cost of asbestos waste disposal was $18.45 per ton and $18.45 per ton for C&D waste. Tonnages were determined at the landfill by weighing each load upon delivery and then weighing the truck and empty box after disposal and then calculating the difference. A total of 244 tons of asbestos debris were disposed in AACM3.

8.10.2.6 Supplies

The project required various miscellaneous supplies including caution tape, Tyvek® coveralls, sorbent booms, decon brushes, polyethylene sheeting, duct tape, spray foam, spray adhesive, etc. Caution tape was billed at $7.95 per roll and a total of six rolls were used. Tyvek ® coveralls were billed at $122.70 per case of 25 coveralls and a total of one case was used. Sorbent booms were billed at $83.16 per bale of four booms and one bale was used. Twenty-inch decon brushes were billed at $4.77 each and a total of three brushes were used for this project. Polyethylene sheeting was billed at $57.44 per six-mil clear 20x100 roll, $82.95 per six-mil 32x100 roll, $98.28 per reinforced six-mil 20x100 roll, and $135.50 per six-mil clear 40x100 roll. A total of six rolls of 20x100 six-mil, ten rolls of 32x100 six-mil, two rolls of 20x100 reinforced six-mil, and six rolls of 40x100 six-mil were used. Duct tape was billed at $91.28 per case of 24 rolls and a total of one case was used. Spray foam was billed at $50.95 per case and a total of one case was used for this project. Spray adhesive was billed at $24.74 per case of 12 cans and a total of one case was used. All supplies were subject to local sales tax (8.25%) plus a 15% markup from the primary contractor.

Two layers of polyethylene sheeting were placed in all roll-off boxes used for waste handling and transportation. The poly sheeting was sealed using spray glue and duct tape to create a burrito wrap of waste debris. The total cost for poly sheeting and supplies was approximately $3,000 and labor costs for lining and sealing were included under the demolition labor. No lining would have been done for the C&D debris that would have resulted from demolition of the building after the NESHAP abatement.

8.10.2.7 Concrete Slab Removal Cost

The concrete slab was not removed at the time of the study but was subsequently removed during the final demolition of remaining property buildings and disposed as non-asbestos waste. The total cost of this removal, transportation, and disposal was $2,643. This cost would have been the same for the NESHAP demolition.

8.10.3 Cost Summary

Table 8-9 presents the documented costs for the AACM demolition and disposal and estimates for NESHAP abatement and demolition of the popcorn building and are summarized both as the cost per ft^2 of footprint (traditional for demolitions) and as cost per ft^2 of RACM surfacing (traditional for abatements).

Table 8-9. AACM3 BUILDING DEMOLITION COSTS

Cost Item	AACM3 Cost , $	ESTIMATED NESHAP Cost, $
Pre-Demolition		
Pre-Demolition Asbestos Inspection	$1,200	$1,200
NESHAP Abatement		
Abatement	0	$17,500
Abatement Worker Monitoring	0	$3,500
Building Demolition		
Track-hoe (Excavator)	$2,255	$1,350
Labor	$10,863	$2,130
Hydrant water	$51	$26
Surfactant	$1,240	0
Transportation and Disposal		
Roll-off Box Rental	$1,088	$1,865 Transportation w/ trailers
Roll-Off Truck Operation	$8,000	
Landfill Disposal Charges	$4,497	$1,405
Supplies (poly sheeting, foam, glue, etc.)	$3,566	N/A
Concrete Slab Removal		
Removal and disposal of concrete	$2,643	$2,643
Summary Costs		
Total Cost	$35,403	$31,593
Unit Cost, $/building ft^2 (2,150 ft^2)	$16.46	$14.69
Unit Cost, $/asbestos ft^2 (7,900 ft^2)	$4.48	$4.00

The AACM3 demolition process still took far longer than expected because of many administrative delays, disruptions caused by other parties, and a learning curve on the AACM3 technology on the part of the contractor that had to be acquired at the last minute. EPA estimates that the AACM3 costs documented in this demonstration are at least 20-percent higher than they would have been without the distractions and with implementing the lessons learned during the study.

8.10.4 Other Price Estimates

Tracy Bramlett of IHST (a licensed asbestos consultant on the project) estimated the cost for abatement to be \$2.50 /ft^2 for surfacing material. Since there were 7900 ft^2 total (2200 ft^2 of popcorn and 5700 ft^2 of wall surfacing), his estimate for abatement was \$14,250. Mr. Bramlett also acquired two blind bids from DSHS licensed abatement contractors ranging from \$13,000 to \$22,000. The bidders did not see the building. EPA used the average of the two bids he received ((\$13,000 + \$22, 000)/2=\$17,500).

8.10.5 Applicability of the costs to different sites

The costs for this demolition in Fort Worth, Texas are very site specific and may vary at other sites according to building type, size, asbestos type and extent, etc. The Texas Department of State Health Services (DSHS) regulations do not allow composite sampling and as such all of the finished sheetrock ceilings and walls would have been required to be removed by a DSHS licensed Asbestos Contractor that was overseen by a DSHS licensed Asbestos Consultant Agency. The landfill used for this project was approximately 30 miles from the job site. The route to the landfill has heavy traffic and some delays were encountered depending upon time, construction and traffic accidents encountered. Use of a less costly but equally effective surfactant would have been beneficial. This method may also vary in cost across the country dependent on factors such as landfill space, distance to an asbestos landfill (that would directly increase transportation costs), and services such as consultants, asbestos workers, equipment rental, etc., that are available within the industry in the specific State.

8.11 Containment

8.11.1 Barrier Wall

Although the three samplers (both air and settled dust) on top of the barrier wall were all non-detect for asbestos, the wall was essentially parallel to the dominant wind direction and very little asbestos would have been expected. Some asbestos was however seen in the air samplers (samplers 15-18 in Figure 5-3) at the ten-ft level that were in front (toward the building) of the wall, particularly during the final cleaning/equipment decon that was conducted immediately in front of the wall.

8.11.2 Water Barrier

The trench that was dug in the soil to collect the runoff water was ineffective because the percolation rate was so high that virtually no water made it to the trench. Lining the trench with plastic was particularly ineffective and became a problem to remove and dispose. Small pockets of water accumulated in the lined trench but a down-gradient flow was never established. If the site conditions had been less permeable, the trench (without the plastic) would have probably been quite effective.

The controls used on the pavement were very effective as the site utilized the natural gradient of the pavement and adjoining curb to channel the water toward the low end of the pavement, where it was effectively captured in a HEPA vac and disposed with the waste.

Removal of the trench would have been far more efficient if the trench had been dug within the reach of the track-hoe as it operated on the pad. This would have prevented the track-hoe from having to track into the mud to reach the ditch and would have greatly reduced the time and cost required to decon the track-hoe. This similarly would have significantly reduced the time and cost of decon activities on the concrete slab, which was re-cleaned several times after soil was tracked back onto it.

SECTION 9 INFERENTIAL STATISTICAL ANALYSES

Due to the large number of censored data, the statistical methods proposed in the QAPP were not always employed. Censored data in this investigation refers to data where the values are less than the analytical sensitivity. In cases where there were less than five percent censored data and substituting one-half the detection limit would not affect the conclusions of the inferential test, the parametric methods proposed in the QAPP were employed, unless the assumptions of the parametric test were not met. In cases where the censored values ranged between five and 85 percent and there were multiple detection limits, nonparametric methods based on multiple detection limits were employed when appropriate. Above 85-percent censoring no descriptive statistics were calculated. When the high level of censoring prohibited inferential analyses using the asbestos concentrations, the data were described using the binomial distribution where the random variable was the probability of a censored value.

All inferential tests were conducted with a non-directional alternative hypothesis. Without any prior information regarding the relationship between asbestos concentrations from the AACM method and background a two-sided alternative was chosen.

In inferential statistical tests, the null hypothesis can be rejected but cannot be proven. If the null hypothesis declares that two populations are assumed equal, the inferential tests can disprove that hypothesis (that they are not equal) but cannot prove that they are equal at a given confidence level.

9.1 Primary Objective

Null hypothesis: The airborne asbestos concentrations (TEM) from the AACM process were equivalent to the airborne asbestos concentrations (TEM) from background (BKGD).

This hypothesis requires the evaluation of data from four different sampling events: pre-wetting of the building, demolition of the building, excavation of the soil, and equipment decon/cleanup. Measurements are for total asbestos s/cm^3 from 18 AACM sampler locations and six background (BKGD) sampler locations. A summary of the four AACM process and BKGD sampling events is provided in Table 9-1.

Table 9-1. SAMPLING EVENT SUMMARY FOR TOTAL AIRBORNE ASBESTOS

Event	Sampler Location	Sample Size	Censored Data		Detection Limits (s/cm^3)
			Percent	Number	
Pre-Wetting	AACM	18	100	18	0.00049
	BKGD	6	83	5	0.00049
Demolition	AACM	18	78	14	0.00047, 0.00048, 0.00049
	BKGD	6	83	5	0.00047, 0.00048, 0.00049
Excavation	AACM	18	94	17	0.00046, 0.00047, 0.00048, 0.00049
	BKGD	6	100	6	0.00048, 0.00049
Clean-up	AACM	18	56	10	0.00047, 0.00048, 0.00049
	BKGD	6	100	6	0.00047, 0.00048, 0.00049

Prior to calculating descriptive statistics and conducting any inferential tests, the data for the four individual sampling events (pre-wetting, demolition, excavation, and clean-up) were combined by sampling location. The data were combined as follows:

- if all four events were non-detects, the largest non-detect value was kept;
- if any of the three events had a detect value, the detect value was kept;
- if more than one of the three events had a detect value, the detect values were summed.

The data are provided in Table 9-2 for the AACM process and Table 9-3 for BKGD.

TABLE 9-2. AIRBORNE ASBESTOS (TEM) FOR THE AACM3 PROCESS, s/cm^3

Sample Location	Wetting	Demolition	Excavation	Cleanup	Total
M01	<0.00049[1]	0.00049	<0.00046	<0.00049	0.00049
M02	<0.00049	<0.00049	<0.00046	<0.00049	<0.00049
M03	<0.00049	<0.00049	<0.00047	0.00049	0.00049
M04	<0.00049	<0.00047	<0.00047	<0.00049	<0.00049
M05	<0.00049	<0.00049	<0.00047	<0.00049	<0.00049
M06	<0.00049	<0.00048	<0.00047	<0.00048	<0.00049
M07	<0.00049	<0.00049	<0.00048	<0.00049	<0.00049
M08	<0.00049	0.00150	<0.00047	<0.00049	0.00150
M09	<0.00049	<0.00049	0.00048	0.0020	0.00248
M10	<0.00049	<0.00048	<0.00048	0.00049	0.00049
M11	<0.00049	<0.00049	<0.00047	<0.00049	<0.00049
M12	<0.00049	<0.00049	<0.00048	<0.00048	<0.00049
M13	<0.00049	0.00190	<0.00046	0.00050	0.00240
M14	<0.00049	<0.00047	<0.00049	0.00290	0.00290
M15	<0.00049	0.00047	<0.00047	0.00240	0.00287
M16	<0.00049	<0.00048	<0.00048	0.00300	0.00300
M17	<0.00049	<0.00047	<0.00048	0.00240	0.00240
M18	<0.00049	<0.00047	<0.00048	<0.00049	<0.00049

[1](<) denotes a censored value, where the minimum detection limit is the reported value.

Table 9-3. AIRBORNE ASBESTOS (TEM) FOR BACKGROUND, s/cm^3

Sample Location	Wetting	Demolition	Excavation	Cleanup	Total
BG01	<0.00049[1]	<0.00048	<0.00048	<0.00048	<0.00049
BG02	0.00150	<0.00047	<0.00049	<0.00047	0.00150
BG03	<0.00049	<0.00048	<0.00049	<0.00048	<0.00049
BG04	<0.00049	<0.00049	<0.00047	<0.00049	<0.00049
BG05	<0.00049	<0.00047	<0.00049	<0.00049	<0.00049
BG06	<0.00049	0.00140	<0.00047	<0.00049	0.00140

[1](<) denotes a censored value, where the minimum detection limit is the reported value.

9.1.1 AACM versus BKGD Sampling Event Comparisons for Airborne Asbestos

To evaluate the primary objective, comparisons were conducted for both the entire AACM process and the individual sampling events that make up the process. Sections 9.1.1.1 through 9.1.1.4 discuss the individual sampling event comparisons.

9.1.1.1 Pre-Wetting AACM versus BKGD

Due to the high number of censored values, 100% for AACM and 83% for BKGD, no descriptive statistics were estimated. The sole value above the detection limit is from the BKGD data set, 0.0015 s/cm^3. Since no inferential test for mean (median) differences could be conducted due to the high number of censored data, a chi-square test for homogeneity with a simulated p-value (based on 2000 replicates) was run using the probability of observing a censored value as the random variable. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the pre-wetting process are the same. The test provided a chi-square test statistic of, $\chi^2 = 3.1304$ with a p-value = 0.2284. *Therefore one would conclude there is no difference in the probability of observing a censored value in the AACM and BKGD pre-wetting data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the pre-wetting process.*

9.1.1.2 Demolition AACM versus BKGD

Due to the fact the censoring in the AACM and BKGD demolition data sets are 78 and 83 percent respectively, a nonparametric method for data with multiple detection limits was employed to estimate the descriptive statistics. The Kaplan-Meier method ranks the detected values by accounting for the number of censored values between each detected value. This information is used to estimate a "survival" function from which descriptive statistics are estimated. The Kaplan-Meier summary statistics for the demolition data are displayed in Table 9-4. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

TABLE 9-4. AIRBORNE ASBESTOS (TEM) KAPLAN-MEIER SUMMARY STATISTICS FOR THE DEMOLITION DATA, s/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	14	NA	0.00045	0.00045
BKGD	6	5	NA	0.00140	NA

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

Since no inferential test for mean (median) differences can be conducted due to the high number of censored data, a chi-square test for homogeneity with simulated a p-value (based on 2000 replicates) was run using the probability of observing a censored value as the random variable. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the demolition process are the same. The test provided a chi-square test statistic of, $\chi^2 = 0.0842$ with a p-value = 1. *Therefore one would conclude there is no difference in the probability of observing a censored value in the AACM and BKGD demolition data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the demolition process.*

9.1.1.3 Excavation AACM versus BKGD

Due to the high number of censored values, 94% for AACM and 100% for BKGD, no descriptive statistics were estimated. Since no inferential test for mean (median) differences could be conducted, a chi-square test for homogeneity with a simulated p-value (based on 2000 replicates) was run using the probability of observing a censored value as the random variable. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the excavation process are the same. The test provided a chi-square of, $\chi^2 = 0.3478$ with a p-value = 1. *Therefore one would conclude there is no difference in the probability of observing a censored value in the AACM and BKGD excavation data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the excavation process.*

9.1.1.4 Clean-up AACM versus BKGD

No inferential test for mean (median) differences was conducted for the clean-up sampling event due to the high number of censored values, 56 percent for AACM and 100 percent for BKGD. The Kaplan Meier summary statistics for the AACM clean-up data are displayed in Table 9-5. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

Table 9-5. AIRBORNE ASBESTOS (TEM) KAPLAN-MEIER SUMMARY STATISTICS FOR THE CLEAN-UP DATA, s/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	10	NA	0.00106	0.00100

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

Since no inferential test for mean (median) differences could be conducted, a chi-square test for homogeneity with a simulated p-value (based on 2000 replicates) was conducted using the number of number of censored and detected observations for both groups. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the clean-up process are the same. The test provided a chi-square of, $\chi^2 = 4$ with a p-value = 0.1294. *Therefore one would conclude there is no difference in the probability of observing a censored value in the AACM and BKGD clean-up data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the clean-up process.*

9.1.2 AACM versus BKGD Combined Sampling Event Comparison for Airborne Asbestos

Due to the fact the percent censoring in the AACM and BKGD data sets from the combined sampling events are 44 and 67 respectively, a nonparametric method for data with multiple detection limits was employed to estimate the descriptive statistics and conduct an inferential test. The Kaplan Meier summary statistics for the combined data are displayed in Table 9-6, and box plots are displayed in Figure 9-1. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

Table 9-6. AIRBORNE ASBESTOS (TEM) KAPLAN-MEIER SUMMARY STATISTICS FOR THE FOUR SAMPLING EVENTS COMBINED, s/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	8	0.00049	0.00127	0.00108
BKGD	6	4	NA	0.00142	0.00005

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

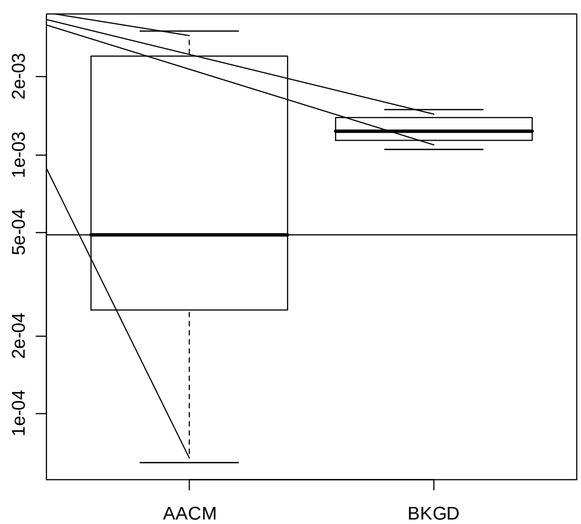

Figure 9-1. Box plots of asbestos (TEM) for the four sampling events combined, s/cm^3. (*The horizontal line is drawn at the highest analytical sensitivity*.)

The Peto-Prentice test for censored data was employed to test for differences in the asbestos concentration distributions for the entire process. The Peto-Prentice test provided a chi-square test statistic of, $\chi^2 = 1.1$ with 1 degree of freedom and a p-value = 0.29. *Based on this test, one would fail to reject the null hypothesis (that the post-demolition and background concentrations were equal).*

9.2 Secondary Objectives

The secondary objectives provide additional information that further characterizes the relationship between the various media and the AACM process. Data from air (total fibers PCM), dust, soil, and pavement are evaluated with descriptive and inferential statistical methods where appropriate.

9.2.1 Total Fibers in Air (PCM)

Null hypothesis: The concentration of total fibers (PCM) from the AACM process were equivalent to the concentration of total fibers (PCM) from background (BKGD).

This hypothesis requires the evaluation of data from four different sampling events: pre-wetting of the building, demolition of the building, excavation of the soil, and equipment decon/cleanup. Measurements are for total fibers (PCM) f/cm^3 from 18 AACM sampler locations and six background (BKGD) sampler locations. A summary of the four AACM and BKGD sampling events is provided in Table 9-7.

Table 9-7. SAMPLING EVENT SUMMARY FOR TOTAL FIBERS

Event	Sampler Location	Sample Size	Censored Data		Detection Limits (f/cm^3)
			Percent	Number	
Pre-Wetting	AACM	18	33	6	0.0011, 0.0012, 0.0013
	BKGD	6	67	4	0.0011, 0.0012
Demolition	AACM	18	6	1	0.0012
	BKGD	6	0	0	NA
Excavation	AACM	18	6	1	0.0004
	BKGD	6	0	0	NA
Clean-up	AACM	18	39	7	0.0010, 0.0011
	BKGD	6	0	0	NA

Prior to calculating descriptive statistics and conducting any inferential tests, the data for the four individual sampling events (pre-wetting, demolition, excavation, and decon/clean-up) were combined by sampling location. The data were combined as follows:

- if all four events were non-detects, the largest non-detect value was kept;
- if any of the three events had a detect value, the detect value was kept;
- if more than one of the three events had a detect value, the detect values were summed.

The data are provided in Table 9-9 for the AACM process and Table 9-10 for BKGD.

TABLE 9-8. TOTAL FIBERS (PCM) FOR THE AACM PROCESS, f/cm^3

Sample Location	Wetting	Demolition	Excavation	Cleanup	Total
M01	<0.0012[1]	0.0007	0.0016	0.0026	0.0049
M02	<0.0011	<0.0012	0.0021	<0.0010	0.0021
M03	0.0014	0.0045	0.0033	0.0015	0.0093
M04	0.0035	0.0053	0.0009	0.0020	0.0117
M05	0.0027	0.0011	0.0009	<0.0010	0.0047
M06	<0.0012	0.0035	0.0022	0.0017	0.0074

Sample Location	Wetting	Demolition	Excavation	Cleanup	Total
M07	0.0023	0.0052	0.0027	0.0028	0.0130
M08	<0.0012	0.0011	0.0016	0.0053	0.0080
M09	0.0026	0.0007	0.0020	<0.0010	0.0053
M10	0.0031	0.0015	0.0016	0.0024	0.0086
M11	0.0019	0.0023	0.0011	0.0019	0.0072
M12	0.0017	0.0024	0.0013	<0.0011	0.0054
M13	<0.0013	0.0016	0.0008	0.0038	0.0062
M14	<0.0012	0.0025	0.0011	<0.0010	0.0036
M15	0.0023	0.0018	0.0007	<0.0010	0.0058
M16	0.0018	0.0024	<0.0004	<0.0010	0.0042
M17	0.0013	0.0013	0.0014	0.0019	0.0059
M18	0.0017	0.0016	0.0021	0.0018	0.0072

[1](<) denotes a censored value, where the minimum detection limit is the reported value.

TABLE 9-9. TOTAL FIBERS (PCM) FOR THE BACKGROUND, f/cm^3

Sample Location	Wetting	Demolition	Excavation	Cleanup	Total
BG01	0.0016	0.0047	0.0023	0.0009	0.0095
BG02	<0.0012[1]	0.0025	0.0014	0.0043	0.0082
BG03	<0.0012	0.0016	0.0024	0.0007	0.0047
BG04	<0.0012	0.0031	0.0016	0.0023	0.0070
BG05	<0.0011	0.0009	0.0018	0.0013	0.0040
BG06	0.0021	0.0018	0.0012	0.0014	0.0065

[1](<) denotes a censored value, where the minimum detection limit is the reported value.

9.2.1.1 AACM versus BKGD Sampling Event Comparisons for Total Fibers

To evaluate the first secondary objective comparisons were conducted for both the entire AACM process and the individual sampling events that make up the process. Sections 9.2.1.1.1through 9.2.1.1.4 discusses the individual sampling event comparisons.

9.2.1.1.1 Pre-Wetting AACM versus BKGD

Due to the fact the censoring in the AACM and BKGD pre-wetting data sets are 67 and 33 percent respectively, a nonparametric method for data with multiple detection limits was employed to estimate the descriptive statistics. The Kaplan-Meier method ranks the detected values by accounting for the number of censored values between each detected value. This information is used to estimate a “survival” function from which descriptive statistics are estimated. The Kaplan-Meier summary statistics for the demolition data are displayed in Table 9-8. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations in the BKGD data set.

TABLE 9-8. TOTAL FIBERS (PCM) KAPLAN-MEIER SUMMARY STATISTICS FOR THE PRE-WETTING DATA, f/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	6	0.0017	0.0019	0.0007
BKGD	6	4	NA	0.0017	0.0003

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

Since no inferential test for mean (median) differences can be conducted due to the high number of censored data, a chi-square test for homogeneity with a simulated p-value (based on 2000 replicates) was run using the probability of observing a censored value as the random variable. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the pre-wetting process are the same. The test provided a chi-square test statistic of, $\chi^2 = 2.0571$ with a p-value = 0.3423. *Therefore one would conclude there is no difference in the probability of observing a censored value in the AACM and BKGD pre-wetting total fiber data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the pre-wetting process.*

9.2.1.1.2 Demolition AACM versus BKGD

Traditional statistical methods were used to evaluate the total fiber demolition data. One half the detection limit value was substituted for the one censored value in the AACM data set. The summary statistics for the demolition data are provided in Table 9-9.

TABLE 9-9. TOTAL FIBER (PCM) SUMMARY STATISTICS FOR THE DEMOLITION DATA, f/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	1	0.0017	0.0023	0.0014
BKGD	6	0	0.0021	0.0024	0.0013

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

A t-test for mean differences was run and provided a p-value of 0.7958. *Based on the results of the t-test, one would fail to reject the null hypothesis of no difference in the mean concentration of total fibers observed during demolition for AACM and BKGD.*

9.2.1.1.3 Excavation AACM versus BKGD

Traditional statistical methods were used to evaluate the total fiber excavation data. One half the detection limit value was substituted for the one censored value in the AACM data set. The summary statistics for the demolition data are provided in Table 9-10.

TABLE 9-10. TOTAL FIBERS (PCM) SUMMARY STATISTICS
FOR THE EXCAVATION DATA, f/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	1	0.0015	0.0015	0.0014
BKGD	6	0	0.0017	0.0018	0.0013

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

A t-test for mean differences was run and provided a p-value of 0.3829. *Based on the results of the t-test, one would fail to reject the null hypothesis of no difference in the mean concentration of total fibers observed during excavation for AACM and BKGD.*

9.2.1.1.4 Clean-up AACM versus BKGD

Due to the fact the censoring in the AACM is 33 percent, a nonparametric method for data with multiple detection limits was employed to estimate the descriptive statistics. The Kaplan-Meier method ranks the detected values by accounting for the number of censored values between each detected value. This information is used to estimate a "survival" function from which descriptive statistics are estimated. The Kaplan-Meier summary statistics for the demolition data are displayed in Table 9-11 (Note that in the BKGD data set where there is no censoring, the Kaplan-Meier estimates are the traditional estimates).

TABLE 9-11. TOTAL FIBERS (PCM) KAPLAN-MEIER SUMMARY STATISTICS
FOR THE CLEAN-UP DATA, f/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	7	0.0017	0.0021	0.0010
BKGD	6	0	0.0013	0.0018	0.0013

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

The Peto-Prentice test for censored data was employed to test for differences in the total fiber distributions for the clean-up data. The Peto-Prentice test provided a chi-square test statistic of, $\chi^2 = 0.0407$ with 1 degree of freedom and a p-value = 0.84. *Based on this test, one would fail to reject the null hypothesis (that the AACM3 perimeter asbestos concentrations were equal to the background asbestos concentrations).*

9.2.1.1.5 AACM versus BKGD Combined Sampling Event Comparisons for Total Fibers

Traditional statistical methods were used to evaluate the total fiber combined data. There are no censored values in either data set. The summary statistics for the demolition data are provided in Table 9-12 and the box plots are displayed in Figure 9-2.

TABLE 9-12. TOTAL FIBERS (PCM) SUMMARY STATISTICS FOR THE COMBINED DATA, f/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	0	0.0060	0.0067	0.0027
BKGD	6	0	0.0067	0.0066	0.0021

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

A t-test for mean differences was run and provided a *p*-value of 0.9674. *Based on the results of the t-test, one would fail to reject the null hypothesis of no difference in the mean concentration of total fibers observed for AACM and BKGD for the combined data.*

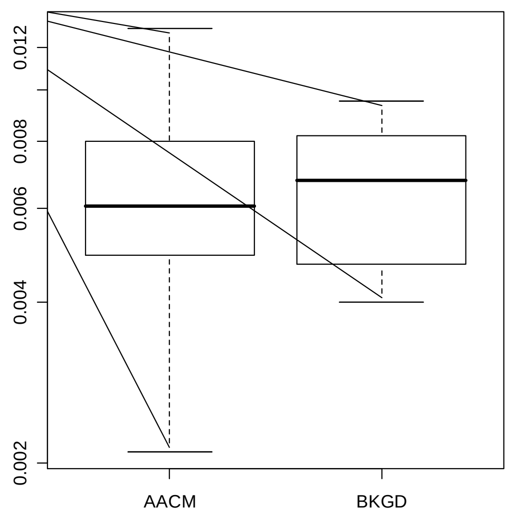

Figure 9-2. Box plots of AACM and BKGD airborne total fibers (PCM) (f/cm^3) for the combined sampling events.

9.2.2 Settled Dust Asbestos Loadings

Null hypothesis: The asbestos concentrations in settled dust from the AACM process are equivalent to the asbestos concentrations in settled dust from background.

This hypothesis requires the evaluation of data from two different sampling events: pre-wetting of the building and demolition/excavation/cleanup. Measurements are for total asbestos s/cm^2 from 18 AACM sampler locations and six BKGD sampler locations. A summary of the two AACM and BKGD sampling events is provided in Table 9-13.

Table 9-13. SAMPLING EVENT SUMMARY FOR SETTLED DUST

Event	Sampler Location	Sample Size	Censored Data		Detection Limits (s/cm^2)
			Percent	Number	
Pre-Wetting	AACM	18	83	15	240
	BKGD	6	67	4	240

Demolition/ Excavation/ Cleanup	AACM	18	11	2	240
	BKGD	6	100	6	240

Prior to calculating descriptive statistics and conducting any inferential tests, data for the two individual sampling events (pre-wetting and demolition/excavation/cleanup) were combined by sampling location. The data were combined as follows:

- if both events were non-detects, the largest non-detect value was kept;
- if either of the two events had a detect value, the detect value was kept;
- if both of the events had a detect value, the detect values were summed.

The data are provided in Table 9-14 for AACM and Table 9-15 for BKGD.

TABLE 9-14. ASBESTOS (TEM) IN SETTLED DUST FOR AACM, s/cm^2

Sample Location	Pre-Wetting	Demolition/ Excavation/ Cleanup	Total
M01	<240	<240	<240
M02	480	<240	480
M03	<240	1,700	1,700
M04	<240	6,000	6,000
M05	<240	1,700	1,700
M06	<240	2,400	2,400
M07	<240	9,200	9,200
M08	<240	15,000	15,000
M09	<240	12,000	12,000
M10	<240	9,200	9,200
M11	480	7,800	8,280
M12	<240	11,000	11,000
M13	<240	13,000	13,000
M14	<240	11,000	11,000
M15	<240	16,000	16,000
M16	<240	14,000	14,000
M17	<240	45,000	45,000
M18	240	480	720

TABLE 9-15. ASBESTOS (TEM) IN SETTLED DUST FOR BKGD, s/cm^2

Sample Location	Pre-Wetting	Demolition/ Excavation/ Cleanup	Total
BG01	1,100,000	<240	1,100,000
BG02	4,600	<240	4,600
BG03	<240	<240	<240

BG04	<240	<240	<240
BG05	<240	<240	<240
BG06	<240	<240	<240

9.2.2.1 AACM versus BKGD Sampling Event Comparisons for Asbestos in Settled Dust

To evaluate the second of the secondary objectives, comparisons were conducted for both the entire AACM process and the two individual sampling events that make up the process. This section discusses the individual sampling event comparisons.

9.2.2.1.1 Pre-Wetting AACM versus BKGD

Due to the fact the censoring in the AACM and BKGD demolition data sets are 83 and 67 percent respectively, a nonparametric method for data with multiple detection limits was employed to estimate the descriptive statistics. The Kaplan-Meier method ranks the detected values by accounting for the number of censored values between each detected value. This information is used to estimate a “survival” function from which descriptive statistics are estimated. The Kaplan-Meier summary statistics for the pre-wetting data are displayed in Table 9-16. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

TABLE 9-16. ASBESTOS (TEM) IN SETTLED DUST KAPLAN-MEIER SUMMARY STATISTICS FOR THE PRE-WETTING, s/cm^2

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	15	NA	0.00127	0.00108
BKGD	6	4	NA	0.00142	0.00005

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

Since no inferential test for mean (median) differences could be conducted, a chi-square test for homogeneity with a simulated p-value (based on 2000 replicates) was conducted using the number of number of censored and detected observations for both groups. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the pre-wetting process are the same. The test provided a chi-square of, $\chi^2 = 0.7579$ with a p-value = 0.5832. *Therefore one would conclude there is no difference in the probability of observing a censored value in the AACM and BKGD pre-wetting data. Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the pre-wetting process.*

9.2.2.1.2 Demolition/Excavation/Clean-up AACM versus BKGD

No inferential test for mean (median) differences was conducted for the demolition/excavation/clean-up sampling event due to the high number of censored values, 11 percent for AACM and 100 percent for BKGD. The Kaplan Meier summary statistics for the AACM demolition/excavation/clean-up data are displayed in Table 9-17.

Table 9-17. ASBESTOS (TEM) IN SETTLED DUST KAPLAN-MEIER SUMMARY STATISTICS FOR THE DEMOLITION/EXCAVATION/CLEAN-UP DATA, s/cm^2

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	2	9,200	9,802	10,345

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.

Since no inferential test for mean (median) differences could be conducted, a chi-square test for homogeneity with a simulated p-value (based on 2000 replicates) was conducted using the number of number of censored and detected observations for both groups. The null hypothesis is the binomial distributions (probability of observing a censored value, the probability of observing a detect value) for the AACM and BKGD during the demolition/excavation/clean-up process are the same. The test provided a chi-square of, $\chi^2 = 16$ with a p-value = 0.001. *Therefore one would conclude there is a difference in the probability of observing a censored value in the AACM and BKGD demolition/excavation/clean-up data; the probability of observing a censored value is greater in the BKGD data set. Although due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the demolition/excavation/clean-up process, it appears the mean concentration of asbestos in the AACM settled dust (9,802 s/cm^2) is greater than BKGD (all concentrations are below 240 s/cm^2).*

9.2.2.1.3 AACM versus BKGD Combined Sampling Event Comparison for Asbestos in Settled Dust

Due to the fact the percent censoring in the AACM and BKGD data sets from the combined events are six and 67 respectively, a nonparametric method for data for censored data was employed to estimate the descriptive statistics and conduct an inferential test. In addition, there appears to be a possible outlying value in the BKGD data set, 1,100,000 s/cm^2. This presumption is also based upon the fact that this sample was taken during the pre-wetting phase of the AACM3. Even though there is no assignable cause for the anomalous value, statistical analyses were conducted with the value as recorded and the value replaced with the next highest detected value, 4,600 s/cm^2. The Kaplan Meier summary statistics for the combined data are displayed in Table 9-18 for the data as recorded and with a substitute for the outlier. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

TABLE 9-18. ASBESTOS (TEM) IN SETTLED DUST KAPLAN-MEIER SUMMARY STATISTICS FOR THE COMBINED DATA, s/cm^2

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	1	9,200	10,202	10,079
BKGD	6	4	NA	187,167	577,326
BKGD – O[2]	6	4	NA	4,600	0

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.
[2] Substituted value for the outlier.

The Peto-Prentice test for censored data was employed to test for AACM versus BKGD differences in the distributions of the asbestos concentrations using the combined data. Two tests were run, one with the potential outlying value as recorded and one with a substitute for the outlier. The Peto-Prentice test provided a chi-square test statistic of, $\chi^2 = 3.5$ with one degree of freedom and a p-value = 0.062 with the outlier in; and a chi-square test statistic of, $\chi^2 = 6.8$ with one degree of freedom and a p-value = 0.009 with a substitute for the outlier. *Since there is no assignable cause for the outlier and the results from the inferential tests at the 0.05 level of significance are inconclusive no inferences can be made regarding the asbestos concentrations in the settled dust of the AACM and BKGD data observed during the combined process of pre-wetting and demolition/excavation/clean-up.*

9.2.3 Pavement and Soil Asbestos Concentrations

9.2.3.1 Pavement

Null hypothesis: The asbestos concentration on pre-demolition pavement is equivalent to the asbestos concentration on post-demolition pavement.

Null hypothesis: The asbestos concentration on post-demolition pavement is equivalent to the asbestos concentration on background pavement.

A summary of the three pavement data sets, pre-demolition, post-demolition, and background, is provided in Table 9-19.

TABLE 9-19. SAMPLING EVENT SUMMARY FOR ASBESTOS ON PAVEMENT

Event	Sample Size	Censored Data		Analytical Sensitivity (s/cm^2)
		Percent	Number	
Pre-Demolition	4	100	4	1,000 730
Post-Demolition	4	100	4	730
Background	5	100	5	730

No inferential analyses were conducted due to 100-percent censored data for all three pavement data sets. *Based on the empirical data, one would conclude there is no evidence to suggest the asbestos concentrations on the pre-demolition versus post-demolition pavement and on the pre-demolition versus background pavement are different.*

9.2.3.2 Soil

Null hypothesis: The asbestos concentration in background soils is equivalent to the asbestos concentration in post excavation soils.

Null hypothesis: The asbestos concentration in pre-demolition soils is equivalent to the asbestos concentration in post-demolition soils.

Null hypothesis: The asbestos concentration in pre-demolition soils is equivalent to the asbestos concentration in post excavation soils.

A summary of the four soil data sets, pre-demolition, post-demolition, post-excavation, and background, is provided in Table 9-20.

Table 9-20. SAMPLING EVENT SUMMARY FOR ASBESTOS IN SOIL

Event	Sample Size	Censored Data		Analytical Sensitivity (TEM structures/g)
		Percent	Number	
Pre-Demolition	6	33	2	1.2E+6
Post-Demolition	6	17	1	1.2E+6
Post-Excavation	6	83	5	1.1E+6, 1.2E+6, 1.3E+6
BKGD	4	50	2	1.2E+6, 1.3E+6

9.2.3.2.1 BKGD Soil versus Post-Excavation Soil

No inferential analysis was conducted using the background and post-excavation data sets due to the high number of censored values, 50 percent for BKGD and 83 percent for post-excavation. Of the three detected values, the largest is from the post-excavation data set, 3.68E+06 s/g. The two detected values from the BKGD set are 1.20E+06 and 1.36E+07 s/g. *Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the post-excavation soils.*

9.2.3.2.2 Pre-Demolition Soil versus Post-Demolition Soil

Due to the fact the percent censoring in the pre-demolition and post-demolition data sets are 33 and 17 respectively, nonparametric methods for data with multiple detection limits were employed to estimate the descriptive statistics and conduct an inferential test. The Kaplan Meier summary statistics for the pre- and post-demolition soil data are displayed in Table 9-21 and the box plots are displayed in Figure 9-3. BOX PLOTS OF ASBESTOS (TEM) (STRUCTURES/G) FOR THE PRE- AND POST-DEMOLITION SOILS.

Table 9-21. ASBESTOS (TEM) KAPLAN-MEIER SUMMARY STATISTICS FOR THE PRE- AND POST-DEMOLITION SOILS, s/g

Group	Sample Size	Number Censored	Median	Mean	Std. Dev.
Pre-Demolition	6	2	1.14E+06	1.72E+06	1.06E+06
Post-Demolition	6	1	1.04E+06	5.44E+06	7.19E+06

The Peto-Prentice test for censored data was employed to test for differences in the asbestos distributions of the pre- and post-demolition soil data. The Peto-Prentice test provided a chi-square test statistic of, $\chi^2 = 0.2$ with 1 degree of freedom and a p-value = 0.67. *Based on this test, one would fail to reject the null hypothesis (that the AACM3 pre-demolition soil asbestos concentrations were equal to the post-demolition soil asbestos concentrations).*

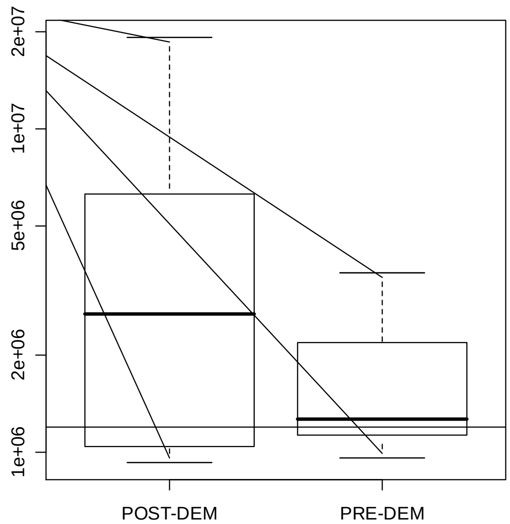

Figure 9-3. Box plots of asbestos (TEM) (structures/g) for the pre- and post-demolition soils. (*The horizontal line is drawn at the highest analytical sensitivity*.)

9.2.3.2.3 Pre-Demolition Soil versus Post-Excavation Soil

No inferential analysis was conducted using the pre-demolition and post-excavation data sets due to the high number of censored values, 33 percent for pre-demolition and 83 percent for post-excavation. The largest detected value is from the post-excavation data set, 3.68E+06 s/g and the second largest is from the pre-demolition data set, 3.59E+06 s/g. *Due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted for the pre-demolition versus post-excavation soils.*

SECTION 10 Summary

The Asbestos NESHAP (National Emission Standards for Hazardous Air Pollutants) generally requires the removal of all Regulated Asbestos-Containing Material (RACM) from a building prior to its demolition. In many circumstances, this removal process can be a costly and time-consuming endeavor and is believed to contribute to the growing crises of abandoned buildings in this country. Under this Alternative Asbestos Control Method (AACM) research project, certain asbestos-containing materials (ACM) were allowed to remain in the building during demolition. In addition to leaving most of the ACM in the building, the AACM process differed from the NESHAP process in that the interior of the building was pre-wetted with amended water (water with a wetting agent added), all demolition and debris-loading activities were continuously wetted with amended water, all runoff was contained, three or more inches of soil were removed after demolition, all materials were disposed of as RACM, and respirators and protective garments were worn by workers throughout the entire demolition process.

This research project (AACM3) is the third of the AACM research efforts, each targeting specific asbestos and building/site configurations. AACM3 evaluated the use of the AACM demolition process on a building which contained significant amounts of asbestos-containing popcorn ceilings and troweled-on surfacing materials.. Separate reports have been issued for AACM1 and AACM2.

At this time, the AACM is a research method only and EPA does not permit its use as an approved work practice under the Asbestos NESHAP for demolishing buildings containing RACM.

Conclusions

The following conclusions are relevant to the demolition of the popcorn building (AACM3) at Fort Worth:

Primary Objective:

- The airborne asbestos concentrations measured in the perimeter ring by transmission electron microscopy (TEM) during the AACM3 demolition process were orders of magnitude below any EPA existing health or performance criterion. At an analytical sensitivity of 0.0005 asbestos structures per cubic centimeter of air (s/cm^3) and corresponding detection limit of 0.015 s/cm^3, the maximum asbestos air concentration was 0.0030 s/cm^3 (six structures observed) in the perimeter monitoring ring for the AACM3 process during demolition of a building with popcorn ceilings and troweled-on surfacing material that contained regulated amounts of asbestos.

- Most of the airborne asbestos (TEM) concentrations were near or below the limit of detection, which was 0.0015 s/cm^3. Due to this limitation, the Peto-Prentice test for censored data (non-detects) was conducted. Based on the results of this inferential test (p-value = 0.29), one would ***fail to reject*** the null hypotheses of no difference in the perimeter airborne asbestos distributions for AACM3 versus background; therefore one cannot conclude the AACM3 and background airborne asbestos concentrations observed during the entire process are different (where *p* represents a strength of evidence that the null hypothesis is true). The smaller the p-value, the stronger the evidence is that the null hypothesis should be rejected. In this study, the null hypothesis was rejected for *p* values less than 0.05.

Secondary Objectives

- No visible emissions were observed by EPA staff during the AACM3 demolition process.

- The fiber concentrations in air from the AACM3 demolition process as measured by phase contrast microscopy (PCM) were not judged to be different from the background fiber concentrations. The statistical analysis (*t*-test for mean differences) indicated that *one would* ***fail to reject*** *the null hypothesis of no difference in the mean concentration of total fibers observed for AACM3 and background… (p=0.97).*

- There was no statistically significant difference in the settled dust asbestos concentrations comparing the background with the perimeter when the entire process (pre-wetting through cleanup) was evaluated because of a high value with no assignable cause that was observed in one of the background samples. The statistical analysis indicated since *… the results from the inferential tests at the 0.05 level of significance are inconclusive, no inferences can be made regarding the asbestos concentrations in the settled dust of the AACM and background data ...*; however, based upon the descriptive statistics, there does appear to be an increase in settled dust asbestos concentrations as a result of the demolition activity.

- In seventeen worker samples taken over the course of the AACM3 demolition process of the popcorn building, only one sample had detectable asbestos and in that one only a single asbestos structure was observed. The extremely low worker breathing zone asbestos concentrations seen in AACM3 offer a significant advantage for the AACM. The Time-Weighted Averages (TWA) were very low (0.002 f/cm^3 max), which is far below the OSHA Permissible Exposure Limit (PEL) of 0.1 f/cm^3 that is based upon PCM analysis.

- The asbestos concentration in the soil after the AACM3 demolition process appeared equal to the background soil asbestos concentration, but there were too many censored data (non-detects) to conduct a meaningful statistical analysis (53-percent non-detects for the background vs. 80-percent non-detects for the post-excavation soil asbestos concentrations). Statistically, the asbestos concentrations in the post-demolition soil were not judged different than the asbestos concentrations in the pre-demolition soils using the Peto-Prentice test for censored data (*p* value=0.67); however, based upon descriptive statistics, they appear so. Based on this test one would ***fail to reject*** the null hypothesis of no difference in the asbestos concentration in pre-demolition and post-demolition soils.

- The asbestos concentrations in the pavement surface samples after the AACM3 process were judged equal to the asbestos concentrations in the background pavement surface samples. All background, pre-demolition, and post-demolition pavement samples were non-detect for asbestos at a <1000 s/cm^2 analytical sensitivity. Since all asbestos concentrations in the pavement surface samples after the AACM3 process were below the analytical sensitivity, no inferential test could be conducted. Based on the empirical data, there is no evidence to suggest the asbestos concentrations on the pre-demolition versus post-demolition pavement and on the pre-demolition versus background pavement are different.

- The concrete slab, which was later removed, had asbestos detected in four of six surface samples.

- No water was released from the AACM3 site. Of the 9500 gallons of amended water added, none required filtration or disposal to the sewer as virtually all either left with the demolition debris or percolated into the soil and was removed with the excavation waste. Water samples taken from pooled sites during the demolition contained asbestos, with a maximum concentration near 100 million structures per liter, thereby justifying the need for soil removal if the water reaches the soil.

- The time required to perform the AACM3 demolition process (3½ days) was about half the time that was estimated to perform the NESHAP (abatement plus demolition) process (six days) for this site. The AACM3 demolition process still took far longer than expected because of many administrative delays, disruptions caused by other parties, and a learning curve on the AACM3 technology on the part of the contractor that had to be acquired at the last minute.

- The total cost of the AACM3 demolition process was about \$35,400 or about \$16.50/ft^2 of building footprint or \$4.48/ft^2 of surfacing material. This cost is estimated to be about 20-percent higher than would have been required, due to many organizational delays that were encountered; part of which were due to the research nature of the effort. The total cost for a NESHAP demolition (abatement plus demolition) of the popcorn building was estimated to be about \$31,600 or \$14.70 /ft^2 of building footprint or \$4.00/ft^2 of surfacing material.

SECTION 11 Lessons Learned

The following are the major "lessons learned" during AACM3:

- Lining the containment ditch with plastic was unnecessary and ineffective,
- More hoses would be beneficial to reduce the time and effort required to move the hose lines,
- Debris containers should be larger to improve efficiency and reduce time,
- Drive-through trucks would be more efficient than roll-offs,
- An insufficient number of roll-off boxes were available,
- Carpet should be removed before demolition as it slows loading process,
- More compacting of the debris should be allowed by AACM method,
- Better pre-communication with asbestos workers applying amended water would have improved efficiency of water application,
- Better training for asbestos workers implementing AACM is required,
- Ways to minimize the footprint of impacted soil, such as covering it with plastic, may be useful to minimize the excavation required and reduce time and equipment decon,
- Wet soil on the equipment tracks is a mess to decon,
- Pre-planning to reduce equipment decon would greatly improve efficiency,
- There are possibly more efficient ways to remove soil than with the track-hoe,
- The trench was just outside the reach of the track-hoe from the slab, which required the track-hoe to constantly move during soil excavation, therefore, keep the trench within reach of the track hoe,
- Puncture the roof the night before to wet areas without attic access, and
- Use of wood pallets or sand on top of the plastic in the bottom of the debris containers may reduce the possibility of puncturing the liners.

While the following items were followed during AACM3, specific wording should be added to the AACM draft method protocol to insure removal of mercury lights and switches, ballasts, and add an emphasis on adherence to all local regulations, some of which may be more stringent than EPA regulations.

SECTION 12 References

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SECTION 13 Appendices

TABLE 13-1. METEOROLOGICAL DATA DURING DEMOLITION

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
Pre-Wetting Sampling on Sunday							
12/16/2007	16:40	3.5	182.4	50.5	26.5	29.57	0
12/16/2007	16:45	2.5	196.2	50.2	27.2	29.56	0
12/16/2007	16:50	2.3	205	50	27.3	29.56	0
12/16/2007	16:55	2.9	198.7	49.7	27.5	29.56	0
12/16/2007	17:00	2.6	165.1	49.6	28.1	29.56	0
12/16/2007	17:05	2	189.1	49.3	29.2	29.56	0
12/16/2007	17:10	1.5	167.5	49	29.9	29.56	0
12/16/2007	17:15	2	201.8	48.7	30.2	29.56	0
12/16/2007	17:20	2.1	209.3	48.4	30.3	29.56	0
12/16/2007	17:25	2.1	204.6	48.1	30.3	29.56	0
12/16/2007	17:30	2.1	204.3	47.9	30.6	29.56	0
12/16/2007	17:35	1.9	198.3	47.6	30.9	29.56	0
12/16/2007	17:40	1.8	198.1	47.3	31.7	29.56	0
12/16/2007	17:45	2	198.1	47.1	32.3	29.56	0
12/16/2007	17:50	1.9	193.8	46.9	32.7	29.56	0
12/16/2007	17:55	2.1	196	46.7	33.2	29.56	0
12/16/2007	18:00	1.6	192.4	46.6	33.3	29.56	0
12/16/2007	18:05	1.6	186.2	46.5	33.2	29.55	0
12/16/2007	18:10	1.6	194.6	46.4	34.1	29.55	0
12/16/2007	18:15	1.4	190.4	46.2	34.5	29.55	0
12/16/2007	18:20	1.1	168.5	45.9	35.5	29.55	0
12/16/2007	18:25	1	129.4	45.6	38	29.55	0
12/16/2007	18:30	1.1	158.9	45.2	39	29.54	0
12/16/2007	18:35	1.2	177	45	39.5	29.54	0
12/16/2007	18:40	1.3	195.1	44.9	39.4	29.55	0
12/16/2007	18:45	1.3	187.4	44.8	39.5	29.55	0
12/16/2007	18:50	1.4	166.6	44.7	39.6	29.56	0
12/16/2007	18:55	2.1	184	44.6	38.3	29.56	0
12/16/2007	19:00	1.7	182.2	44.5	37.2	29.56	0
12/16/2007	19:05	1.4	170.2	44.4	37.2	29.56	0
12/16/2007	19:10	1.3	184.8	44.2	38.8	29.56	0
12/16/2007	19:15	1.5	187	44	39.9	29.56	0
12/16/2007	19:20	2.2	192.5	43.9	40.5	29.56	0
12/16/2007	19:25	1.9	196.7	44	41.5	29.57	0
12/16/2007	19:30	2.6	201.5	44	42.7	29.57	0
12/16/2007	19:35	2.7	203.8	44	43.9	29.57	0
12/16/2007	19:40	2.5	194.5	43.9	44.2	29.57	0
12/16/2007	19:45	2.9	191.2	43.9	43.9	29.57	0
12/16/2007	19:50	2.8	188.3	43.8	44.5	29.57	0
12/16/2007	19:55	2.9	184.9	43.7	45.7	29.57	0
12/16/2007	20:00	2.9	194.5	43.6	46.1	29.57	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/16/2007	20:05	2.8	194.3	43.5	47.1	29.57	0
12/16/2007	20:10	2.3	192.2	43.3	48.3	29.57	0
12/16/2007	20:15	2.3	179.4	43.1	48.8	29.56	0
12/16/2007	20:20	2.6	193.4	43	49.6	29.57	0
12/16/2007	20:25	3.1	191.2	42.8	49.1	29.57	0
12/16/2007	20:30	2.7	193.9	42.7	49.1	29.57	0
12/16/2007	20:35	2.3	194.6	42.6	49.8	29.57	0
12/16/2007	20:40	2.1	193.4	42.5	50.7	29.56	0
12/16/2007	20:45	2	197.8	42.3	51.3	29.56	0
12/16/2007	20:50	2.6	188.9	42.1	51	29.56	0
12/16/2007	20:55	2.3	193.7	42	50.7	29.56	0
12/16/2007	21:00	2.8	206	41.9	50.1	29.57	0
12/16/2007	21:05	3.7	211.6	41.9	49	29.57	0
12/16/2007	21:10	3.4	210.3	42	48.5	29.57	0
12/16/2007	21:15	2.7	209.9	41.8	49.2	29.57	0
12/16/2007	21:20	2.8	205	41.5	49.7	29.57	0
12/16/2007	21:25	3.1	207.2	41.3	50.2	29.57	0
12/16/2007	21:30	3.3	211	41	50.7	29.57	0
12/16/2007	21:35	3.7	210.4	40.8	50.6	29.57	0
12/16/2007	21:40	3.1	208.1	40.6	50.2	29.57	0
12/16/2007	21:45	3.2	210.6	40.4	50.1	29.57	0
12/16/2007	21:50	3	208.2	40.3	50.3	29.57	0
12/16/2007	21:55	3.4	209.9	40.2	50.8	29.57	0
12/16/2007	22:00	3.2	205.1	40	51	29.57	0
12/16/2007	22:05	3.1	202.8	39.9	50.8	29.57	0
12/16/2007	22:10	3.1	202.8	39.9	50.7	29.57	0
12/16/2007	22:15	3.7	205.6	39.8	50.3	29.57	0
12/16/2007	22:20	3.1	202	39.7	50.1	29.57	0
12/16/2007	22:25	3.7	194.9	39.6	50	29.57	0
12/16/2007	22:30	3.9	192	39.7	49.6	29.57	0
12/16/2007	22:35	3.7	195.2	39.9	50	29.57	0
12/16/2007	22:40	3.9	211.5	39.9	50.2	29.57	0
12/16/2007	22:45	4	212.3	40	49.9	29.57	0
12/16/2007	22:50	3.9	210.7	39.9	50.7	29.57	0
12/16/2007	22:55	4	213.7	39.7	51	29.58	0
12/16/2007	23:00	3.3	216.8	39.4	51.5	29.58	0
12/16/2007	23:05	3.2	213.4	39	51.8	29.58	0
12/16/2007	23:10	3.7	212.7	38.8	51.3	29.58	0
12/16/2007	23:15	2.8	218.1	38.7	50.8	29.58	0
12/16/2007	23:20	2.9	235.3	38.6	51.3	29.58	0
12/16/2007	23:25	2.3	226.8	38.2	52.4	29.58	0
12/16/2007	23:30	2.2	232.5	37.9	52.6	29.58	0
12/16/2007	23:35	2.4	236.9	37.8	52.7	29.58	0
12/16/2007	23:40	2.9	218.1	37.6	52.9	29.58	0
12/16/2007	23:45	2.7	220.6	37.5	52.9	29.57	0
12/16/2007	23:50	3.4	212.9	37.5	52.6	29.57	0
12/16/2007	23:55	3.4	212.6	37.6	52.3	29.57	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/16/2007	24:00:00	3.7	210.6	37.6	51.9	29.57	0
12/17/2007	0:05	3.3	209	37.7	52.1	29.57	0
12/17/2007	0:10	2.7	213.2	37.5	52.8	29.57	0
12/17/2007	0:15	1.6	213.1	37.3	53	29.57	0
12/17/2007	0:20	1.4	253	37.1	53.3	29.57	0
12/17/2007	0:25	1.5	266.7	36.8	54.9	29.57	0
12/17/2007	0:30	1	242.1	36.3	56.9	29.57	0
12/17/2007	0:35	0.8	42	35.5	59.4	29.57	0
12/17/2007	0:40	0.8	39.6	34.8	61.8	29.57	0
12/17/2007	0:45	0.8	22.5	34.1	63.5	29.56	0
12/17/2007	0:50	2.1	247.5	33.9	63	29.56	0
12/17/2007	0:55	2.1	223.7	34.3	61.7	29.56	0
12/17/2007	1:00	1.9	237.2	34.4	61.8	29.56	0
12/17/2007	1:05	2.4	246.4	34.7	59.1	29.56	0
12/17/2007	1:10	2.4	238.7	35.2	57.7	29.55	0
12/17/2007	1:15	2.6	237.4	35.6	56.5	29.55	0
12/17/2007	1:20	2.6	233.2	36.1	55.5	29.55	0
12/17/2007	1:25	2.8	229.9	36.3	55.1	29.55	0
12/17/2007	1:30	2.7	219	36.3	55.2	29.55	0
12/17/2007	1:35	2.4	199.2	36.5	54.1	29.54	0
12/17/2007	1:40	2.1	245.4	36.7	54.1	29.55	0
12/17/2007	1:45	2.4	240.5	36.7	54.3	29.55	0
12/17/2007	1:50	2.3	210.4	36.4	55.1	29.55	0
12/17/2007	1:55	2.6	216.8	36.4	54.8	29.55	0
12/17/2007	2:00	1.3	222.7	36.4	54.6	29.55	0
12/17/2007	2:05	1.2	18.3	36	57.3	29.55	0
12/17/2007	2:10	1.4	29.8	35	61.6	29.55	0
12/17/2007	2:15	0.8	24.6	33.9	63.7	29.55	0
12/17/2007	2:20	0.9	49.4	33.2	65.4	29.55	0
12/17/2007	2:25	1.4	24.9	32.7	66.7	29.55	0
12/17/2007	2:30	1.2	339.6	32.4	67.3	29.55	0
12/17/2007	2:35	1.6	233.3	32.1	68	29.55	0
12/17/2007	2:40	1.3	203.4	31.9	67.8	29.55	0
12/17/2007	2:45	1.4	221.6	32	67.3	29.55	0
12/17/2007	2:50	1	221.8	32.2	67.3	29.55	0
12/17/2007	2:55	1.7	237.1	32.6	66.6	29.56	0
12/17/2007	3:00	1.7	227.2	32.8	66.1	29.56	0
12/17/2007	3:05	1.3	200.3	32.9	66.3	29.56	0
12/17/2007	3:10	1.6	228.7	32.8	66.5	29.56	0
12/17/2007	3:15	1	219.3	33	66	29.56	0
12/17/2007	3:20	0.8	149.1	32.9	66	29.56	0
12/17/2007	3:25	0.9	78.8	32.8	67.1	29.55	0
12/17/2007	3:30	1.1	17.6	32.7	68.1	29.55	0
12/17/2007	3:35	0.8	49.3	32.5	68.8	29.55	0
12/17/2007	3:40	0.8	86.4	32.3	69.7	29.55	0
12/17/2007	3:45	0.8	55.5	32	71.1	29.55	0
12/17/2007	3:50	0.8	41.5	31.8	71.5	29.56	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/17/2007	3:55	0.8	55.9	31.6	71.6	29.55	0
12/17/2007	4:00	1.4	359.5	31.5	71.9	29.56	0
12/17/2007	4:05	1.2	18	31.4	72.3	29.55	0
12/17/2007	4:10	0.8	27.8	31.2	72.8	29.55	0
12/17/2007	4:15	0.8	63	31	73.1	29.55	0
12/17/2007	4:20	0.8	184.9	30.8	73.7	29.55	0
12/17/2007	4:25	1.6	242.4	31.1	71.8	29.55	0
12/17/2007	4:30	2.2	225.3	33	65.9	29.54	0
12/17/2007	4:35	2.6	209.5	34.4	63.3	29.54	0
12/17/2007	4:40	2.2	222.6	35.1	62.3	29.54	0
12/17/2007	4:45	2.9	219.1	35.4	61.7	29.54	0
12/17/2007	4:50	2.9	234.6	35.8	61.1	29.55	0
12/17/2007	4:55	2.4	231.8	35.7	61.5	29.55	0
12/17/2007	5:00	2.6	226.3	35.5	61.7	29.55	0
12/17/2007	5:05	2.5	229.9	35.4	61.6	29.55	0
12/17/2007	5:10	2.8	231.6	35.4	61.8	29.55	0
12/17/2007	5:15	2.8	231.2	35.3	62	29.55	0
12/17/2007	5:20	2.4	229.2	35.1	62.3	29.54	0
12/17/2007	5:25	2.7	209.6	34.9	62.5	29.54	0
12/17/2007	5:30	3	210.6	35.1	62.3	29.54	0
12/17/2007	5:35	2.9	209	35.2	62.5	29.55	0
12/17/2007	5:40	2.8	214.2	35.2	62.6	29.55	0
12/17/2007	5:45	2.1	229.7	35.2	62.6	29.55	0
12/17/2007	5:50	2.7	237.1	35.2	62.8	29.56	0
12/17/2007	5:55	3.1	239.7	35.2	63.2	29.56	0
12/17/2007	6:00	2.2	226.6	35	63.9	29.56	0
12/17/2007	6:05	2.4	235.2	34.7	64.1	29.56	0
12/17/2007	6:10	2.4	240.2	34.6	64.5	29.56	0
12/17/2007	6:15	2.7	236.3	34.4	64.8	29.57	0
12/17/2007	6:20	2.6	235.9	34.3	64.9	29.56	0
12/17/2007	6:25	2.1	216.5	34.2	64.8	29.56	0
12/17/2007	6:30	2.6	213.6	34.3	64.1	29.56	0
Max		4	359.5	50.5	73.7	29.58	0
Min		0.8	17.6	30.8	26.5	29.54	0
Mean		2.2	192.5	39.0	52.7	29.56	0
Sampling During Demolition and Debris Loading (Monday)							
12/17/2007	6:30	2.6	213.6	34.3	64.1	29.56	0
12/17/2007	6:35	2.9	214.6	34.5	62.9	29.56	0
12/17/2007	6:40	3.1	209.8	34.8	62	29.56	0
12/17/2007	6:45	2.5	221.6	35	61.8	29.56	0
12/17/2007	6:50	2.8	212.3	34.9	61.9	29.56	0
12/17/2007	6:55	3.3	211.3	34.9	61.8	29.56	0
12/17/2007	7:00	2.7	214.1	34.9	61.8	29.56	0
12/17/2007	7:05	2.9	213.5	34.9	61.8	29.56	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/17/2007	7:10	2.4	226.4	34.9	62.1	29.56	0
12/17/2007	7:15	3.2	247	34.9	61.8	29.57	0
12/17/2007	7:20	2.4	243.9	34.8	62.1	29.57	0
12/17/2007	7:25	2.5	239.4	34.7	62.3	29.57	0
12/17/2007	7:30	2.2	219.9	34.7	62.2	29.57	0
12/17/2007	7:35	2.4	219.7	34.7	62	29.57	0
12/17/2007	7:40	2.8	218.1	34.8	61.8	29.57	0
12/17/2007	7:45	3	215.7	34.8	61.5	29.57	0
12/17/2007	7:50	2.5	229.9	34.9	61.3	29.57	0
12/17/2007	7:55	2.6	227.6	35	61.2	29.58	0
12/17/2007	8:00	2.8	214.8	35.1	61	29.57	0
12/17/2007	8:05	3.5	211.7	35.4	59.8	29.57	0
12/17/2007	8:10	3.4	209.8	35.6	59.3	29.57	0
12/17/2007	8:15	2.9	207.4	35.8	59	29.57	0
12/17/2007	8:20	3.7	213.8	36.1	58.2	29.57	0
12/17/2007	8:25	3.2	210.2	36.6	57.4	29.57	0
12/17/2007	8:30	3.5	212.6	37.6	55.5	29.57	0
12/17/2007	8:35	3.4	216.9	38.8	54	29.57	0
12/17/2007	8:40	3.4	207.4	39.4	53.4	29.57	0
12/17/2007	8:45	4	205.8	39.9	52.7	29.57	0
12/17/2007	8:50	4	209.9	40.1	52.2	29.58	0
12/17/2007	8:55	3.9	201.7	40.6	51.1	29.58	0
12/17/2007	9:00	4.2	214.1	41.2	50.4	29.59	0
12/17/2007	9:05	4.6	199	41.5	50.4	29.58	0
12/17/2007	9:10	4.8	215.7	41.4	50.4	29.58	0
12/17/2007	9:15	4.6	220.4	41.8	49.6	29.59	0
12/17/2007	9:20	4.6	216.4	42.3	48.9	29.59	0
12/17/2007	9:25	4.3	219.1	42.6	48.7	29.59	0
12/17/2007	9:30	4.2	222.3	42.8	48.4	29.59	0
12/17/2007	9:35	4.5	212.7	43.2	47.8	29.59	0
12/17/2007	9:40	5.1	207	43.1	47.2	29.6	0
12/17/2007	9:45	4.8	229	43.7	46.3	29.6	0
12/17/2007	9:50	4.3	213.9	44.4	45.4	29.6	0
12/17/2007	9:55	4.1	215.8	45.2	44.4	29.6	0
12/17/2007	10:00	4.1	199.6	46	43.5	29.6	0
12/17/2007	10:05	4.2	176.9	46.3	42.9	29.6	0
12/17/2007	10:10	4.2	200.4	46.4	43.3	29.59	0
12/17/2007	10:15	4.8	208.7	46.8	42.1	29.59	0
12/17/2007	10:20	4.8	206.7	47	41.3	29.59	0
12/17/2007	10:25	4.8	210.3	47.3	40.6	29.59	0
12/17/2007	10:30	5	199.5	47.6	39.4	29.59	0
12/17/2007	10:35	4.9	208.7	48.1	37.7	29.59	0
12/17/2007	10:40	5.6	207.5	48.2	35.8	29.59	0
12/17/2007	10:45	6	209.2	48.4	34.5	29.59	0
12/17/2007	10:50	5.2	198.6	48.6	33.7	29.59	0
12/17/2007	10:55	6.4	200.9	49.1	31.1	29.59	0.01
12/17/2007	11:00	5.7	208.6	49.2	31.6	29.59	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/17/2007	11:05	7	220.4	49.3	31.5	29.59	0
12/17/2007	11:10	6.2	211.5	49.2	32.8	29.59	0
12/17/2007	11:15	5.3	194.9	49.6	33	29.58	0
12/17/2007	11:20	6.1	200.1	50.2	30.2	29.58	0
12/17/2007	11:25	7.4	214.3	50.5	29.5	29.57	0
12/17/2007	11:30	6.2	194.1	50.5	30.6	29.57	0
12/17/2007	11:35	5.3	202.9	50.8	32.3	29.57	0
12/17/2007	11:40	5.3	213.5	51.1	31.8	29.57	0
12/17/2007	11:45	5.9	200.8	51.3	31.8	29.57	0
12/17/2007	11:50	6.1	202.1	51.2	30.9	29.57	0
12/17/2007	11:55	6.4	203.5	51.3	30.8	29.56	0
12/17/2007	12:00	5.7	189.8	51.5	30.9	29.56	0
12/17/2007	12:05	5.6	203.4	51.8	30.6	29.56	0
12/17/2007	12:10	5.5	184.4	52.2	30.6	29.55	0
12/17/2007	12:15	6.9	194.6	52	30.8	29.54	0
12/17/2007	12:20	6.3	192.8	51.6	31.2	29.54	0
12/17/2007	12:25	5.9	186.5	51.9	31.3	29.54	0
12/17/2007	12:30	5.4	180	52.1	31.2	29.53	0
12/17/2007	12:35	5.6	199.5	52.3	30.8	29.53	0
12/17/2007	12:40	5.7	193.1	52.4	29.2	29.53	0
12/17/2007	12:45	5.2	187.4	52.4	28.7	29.53	0
12/17/2007	12:50	6	192.5	52.5	27.3	29.53	0
12/17/2007	12:55	6	199.6	52.4	28.5	29.53	0
12/17/2007	13:00	5.3	195.4	52.7	28.4	29.53	0
12/17/2007	13:05	7.1	214.8	53	26.2	29.52	0
12/17/2007	13:10	6.4	205.1	52.9	26.1	29.52	0
12/17/2007	13:15	7.4	218.5	52.8	27.2	29.51	0
12/17/2007	13:20	6.6	214.7	52.6	28.9	29.5	0
12/17/2007	13:25	5.7	205.7	52.4	30.1	29.5	0
12/17/2007	13:30	5.1	180.3	52.4	29.7	29.5	0
12/17/2007	13:35	5.4	190.4	52.2	30	29.5	0
12/17/2007	13:40	5.5	184.7	52.9	30.9	29.49	0
12/17/2007	13:45	6.1	182.5	53.1	29.1	29.49	0
12/17/2007	13:50	4.9	186.8	52.8	30.1	29.49	0
12/17/2007	13:55	5.8	186.5	52.8	30.1	29.48	0
12/17/2007	14:00	5.5	202.7	53.2	30.1	29.48	0
12/17/2007	14:05	5.6	187.9	53.8	30.7	29.48	0
12/17/2007	14:10	5.8	200	53.8	31.7	29.48	0
12/17/2007	14:15	5.3	180.2	54	28.1	29.48	0
12/17/2007	14:20	6.4	189.4	54	28	29.47	0
12/17/2007	14:25	5.6	194	54	27.3	29.47	0
12/17/2007	14:30	6.4	184	54.1	27.9	29.47	0
12/17/2007	14:35	6.4	183.7	54	28.4	29.46	0
12/17/2007	14:40	6.2	198.2	53.9	29.2	29.47	0
12/17/2007	14:45	5.8	190.9	54.3	29.7	29.46	0
12/17/2007	14:50	4.9	193.8	54.4	28.7	29.46	0
12/17/2007	14:55	5.6	208.4	55	28	29.46	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/17/2007	15:00	5.3	193.2	55.1	28.5	29.46	0
12/17/2007	15:05	5.4	193	55	28.3	29.46	0
12/17/2007	15:10	5.8	197.5	54.8	29.3	29.46	0
12/17/2007	15:15	5.4	186	53.9	31.2	29.46	0
12/17/2007	15:20	6	205.4	53.2	32.8	29.46	0
12/17/2007	15:25	5.2	204	52.8	33.3	29.46	0
12/17/2007	15:30	5.6	208.3	52.7	33.8	29.46	0
12/17/2007	15:35	5	195.3	52.4	33.6	29.46	0
12/17/2007	15:40	6	203.4	52.6	33.7	29.46	0
12/17/2007	15:45	5.1	190.1	52.6	34.5	29.45	0
12/17/2007	15:50	5.6	198	52.7	34.9	29.45	0
12/17/2007	15:55	5.4	192	52.5	35	29.45	0
12/17/2007	16:00	5.6	184.9	52.2	34.7	29.45	0
12/17/2007	16:05	5.4	186.4	51.8	35.6	29.45	0
12/17/2007	16:10	6.3	185.4	51.5	36.6	29.45	0
12/17/2007	16:15	4.8	190.6	51.4	37.5	29.44	0
12/17/2007	16:20	4.7	200.9	51.3	38.2	29.44	0
12/17/2007	16:25	4.6	186.7	51.3	38.5	29.44	0
12/17/2007	16:30	5.1	196	51.3	39	29.44	0
12/17/2007	16:35	4.9	202	51.1	39.2	29.44	0
12/17/2007	16:40	4.1	192.4	50.9	39.6	29.44	0
12/17/2007	16:45	3.8	192	50.8	39.8	29.44	0
12/17/2007	16:50	4.8	190.6	50.7	37.5	29.44	0
12/17/2007	16:55	5.2	191.5	50.5	35.8	29.45	0
12/17/2007	17:00	5.4	185.7	50.4	36	29.45	0
12/17/2007	17:05	5	192.2	50.2	35.5	29.45	0
12/17/2007	17:10	5.4	194.5	50	35.6	29.45	0
12/17/2007	17:15	4.9	198.1	49.9	35.7	29.45	0
12/17/2007	17:20	5.2	199.3	49.7	36.3	29.44	0
12/17/2007	17:25	4.6	188.3	49.4	37.4	29.44	0
12/17/2007	17:30	4.2	193.7	49.1	38.5	29.44	0
12/17/2007	17:35	4.5	190.3	49	39.1	29.44	0
12/17/2007	17:40	4.6	193.1	48.7	39.9	29.44	0
12/17/2007	17:45	4.6	200.3	48.6	40.5	29.44	0
12/17/2007	17:50	4	196.9	48.4	41.1	29.44	0
12/17/2007	17:55	3.3	198.4	48.1	42	29.44	0
12/17/2007	18:00	3.7	193.6	48	42.5	29.44	0
12/17/2007	18:05	3.8	190.6	47.9	43.3	29.44	0
12/17/2007	18:10	3.6	191.8	47.8	43.6	29.44	0
12/17/2007	18:15	4.1	199.4	47.7	44.2	29.44	0
12/17/2007	18:20	3.6	188.2	47.6	44.6	29.44	0
12/17/2007	18:25	3.5	192	47.5	45.3	29.44	0
12/17/2007	18:30	3.8	190.9	47.3	45.7	29.45	0
12/17/2007	18:35	3.8	195.3	47.2	45.6	29.44	0
12/17/2007	18:40	3.8	198.5	47.1	45.5	29.44	0
12/17/2007	18:45	4.1	187.2	47	45.6	29.44	0
12/17/2007	18:50	4.5	191.4	47	45.7	29.44	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/17/2007	18:55	3.9	191.4	46.9	46	29.44	0
12/17/2007	19:00	3.9	198.4	46.8	46.5	29.44	0
12/17/2007	19:05	3.7	193.7	46.8	46.6	29.44	0
12/17/2007	19:10	4	186.9	46.8	46.5	29.44	0
12/17/2007	19:15	3.5	200.5	46.6	46.9	29.44	0
12/17/2007	19:20	3.7	192.8	46.5	46.6	29.44	0
12/17/2007	19:25	3.8	195.4	46.4	46.5	29.44	0
12/17/2007	19:30	4.2	190.2	46.4	46.4	29.44	0
12/17/2007	19:35	4	196.8	46.4	46.3	29.44	0
12/17/2007	19:40	3.7	197.6	46.3	46.6	29.44	0
12/17/2007	19:45	3.7	194.1	46.3	46.6	29.44	0
12/17/2007	19:50	3.4	198.4	46.2	46.9	29.44	0
12/17/2007	19:55	3.6	195.4	46.1	47.2	29.44	0
12/17/2007	20:00	3.3	192.9	46.1	47.5	29.44	0
12/17/2007	20:05	3.9	193.9	46.1	47.9	29.44	0
12/17/2007	20:10	4.1	187.9	46.1	48.5	29.44	0
12/17/2007	20:15	4.1	194.2	46	49.2	29.44	0
Max		7.4	247	55.1	64.1	29.6	0.01
Min		2.2	176.9	34.3	26.1	29.44	0
Mean		4.7	201.2	47.2	41.3	29.51	0
12/17/2007	20:20	4	198.1	45.9	49.7	29.44	0
12/17/2007	20:25	4.2	190.2	45.8	50.2	29.43	0
12/17/2007	20:30	4.1	195.9	45.7	50.8	29.43	0
12/17/2007	20:35	3.6	195.6	45.6	51.3	29.43	0
12/17/2007	20:40	3.6	197.4	45.4	51.9	29.43	0
12/17/2007	20:45	3.7	200.9	45.3	52.4	29.43	0
12/17/2007	20:50	3	197.8	45.2	52.9	29.43	0
12/17/2007	20:55	4.4	205.2	45.1	53.4	29.43	0
12/17/2007	21:00	3.8	206.5	45	54	29.43	0
12/17/2007	21:05	4.3	211	44.9	54.4	29.42	0
12/17/2007	21:10	3.6	197	44.9	54.7	29.43	0
12/17/2007	21:15	4.5	211.2	44.8	55	29.43	0
12/17/2007	21:20	3.9	207.5	44.6	55.2	29.42	0
12/17/2007	21:25	3.5	200.7	44.5	55.7	29.42	0
12/17/2007	21:30	3.7	208.6	44.4	56.2	29.42	0
12/17/2007	21:35	3.3	211.9	44.2	56.6	29.42	0
12/17/2007	21:40	4.1	212	44.1	56.8	29.42	0
12/17/2007	21:45	3.8	206.4	44	57.3	29.42	0
12/17/2007	21:50	4.1	208.1	43.9	57.8	29.42	0
12/17/2007	21:55	3.2	205.1	43.9	58.2	29.42	0
12/17/2007	22:00	2.9	196.3	43.9	58.3	29.42	0
12/17/2007	22:05	2.9	199.6	43.8	58.7	29.42	0
12/17/2007	22:10	3.5	207.4	43.7	59.1	29.42	0
12/17/2007	22:15	2.8	197	43.6	59.5	29.42	0
12/17/2007	22:20	3	191.7	43.5	60	29.41	0
12/17/2007	22:25	3.2	188.2	43.5	60.5	29.41	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/17/2007	22:30	2.7	198.9	43.4	60.9	29.41	0
12/17/2007	22:35	2.7	197.9	43.3	61	29.41	0
12/17/2007	22:40	3	209.6	43.2	61.4	29.41	0
12/17/2007	22:45	3	212	43	61.9	29.41	0
12/17/2007	22:50	2.4	213	42.8	62.3	29.41	0
12/17/2007	22:55	1.9	205.7	42.6	62.7	29.41	0
12/17/2007	23:00	2.3	209.5	42.5	63	29.41	0
12/17/2007	23:05	2.6	199.1	42.4	63.4	29.41	0
12/17/2007	23:10	2.6	190	42.4	63.5	29.41	0
12/17/2007	23:15	2.3	211.6	42.3	63.8	29.41	0
12/17/2007	23:20	2.4	209.2	42.2	64.3	29.41	0
12/17/2007	23:25	2.6	203	42.2	64.6	29.41	0
12/17/2007	23:30	2.8	192.9	42.3	64.6	29.41	0
12/17/2007	23:35	2.3	199.2	42.5	64.8	29.41	0
12/17/2007	23:40	2.4	203	42.4	65.2	29.41	0
12/17/2007	23:45	2.8	202.4	42.4	65.6	29.41	0
12/17/2007	23:50	3.2	199.3	42.5	65.7	29.41	0
12/17/2007	23:55	3.5	196	42.6	65.7	29.41	0
12/17/2007	24:00:00	3.3	189.6	42.6	65.9	29.4	0
12/18/2007	0:05	3	191.4	42.7	66	29.4	0
12/18/2007	0:10	3.3	193	42.7	66.3	29.39	0
12/18/2007	0:15	4.2	190.6	42.8	66.7	29.39	0
12/18/2007	0:20	3.4	196.9	42.9	67	29.39	0
12/18/2007	0:25	3.9	193.9	42.8	68	29.39	0
12/18/2007	0:30	4.2	187.6	42.9	68.1	29.39	0
12/18/2007	0:35	3.3	194.3	42.9	68.1	29.39	0
12/18/2007	0:40	3.5	193.5	42.9	68.5	29.4	0
12/18/2007	0:45	2.9	212.1	42.7	69.2	29.4	0
12/18/2007	0:50	3.1	196	42.6	69.5	29.4	0
12/18/2007	0:55	3.5	189.5	42.5	69.6	29.4	0
12/18/2007	1:00	3.6	187.9	42.5	69.8	29.4	0
12/18/2007	1:05	3.7	191.9	42.4	69.9	29.39	0
12/18/2007	1:10	3.5	194	42.3	70.3	29.39	0
12/18/2007	1:15	4.1	201	42.3	70.6	29.39	0
12/18/2007	1:20	4.5	189.7	42.5	70.5	29.39	0
12/18/2007	1:25	4.7	196.3	42.6	70.6	29.38	0
12/18/2007	1:30	4.4	188.7	42.8	70.7	29.38	0
12/18/2007	1:35	4.1	190.3	42.8	71.2	29.38	0
12/18/2007	1:40	4.1	194.7	42.9	71.7	29.38	0
12/18/2007	1:45	4.4	187	42.8	71.7	29.38	0
12/18/2007	1:50	4.1	184.4	42.6	72.1	29.38	0
12/18/2007	1:55	3.5	190.6	42.4	72.6	29.38	0
12/18/2007	2:00	3	191.6	42.3	73.2	29.38	0
12/18/2007	2:05	4	190.4	42.1	73.5	29.39	0
12/18/2007	2:10	4	192.9	42	73.9	29.39	0
12/18/2007	2:15	3.5	191.4	41.9	74.3	29.38	0
12/18/2007	2:20	4.4	187.6	41.9	74.6	29.38	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/18/2007	2:25	4.3	190	41.9	74.8	29.38	0
12/18/2007	2:30	4.2	193.4	41.9	75.1	29.37	0
12/18/2007	2:35	4.5	196	41.9	75.6	29.37	0
12/18/2007	2:40	4.4	184.6	42	76	29.37	0
12/18/2007	2:45	4.5	197.8	42	76.4	29.37	0
12/18/2007	2:50	4.1	193.6	42.1	76.9	29.37	0
12/18/2007	2:55	4.9	192.6	42.1	77.3	29.36	0
12/18/2007	3:00	4.8	199.6	42.1	77.9	29.36	0
12/18/2007	3:05	4.6	195	42.2	78.5	29.36	0
12/18/2007	3:10	4.6	198.9	42.3	78.7	29.36	0
12/18/2007	3:15	4.8	205.9	42.3	78.9	29.36	0
12/18/2007	3:20	5	208.6	42.3	79.3	29.36	0
12/18/2007	3:25	4.4	198	42.3	79.7	29.35	0
12/18/2007	3:30	4.5	199.6	42.3	80	29.35	0
12/18/2007	3:35	5	194.7	42.3	80.3	29.35	0
12/18/2007	3:40	4.2	205.8	42.2	80.5	29.35	0
12/18/2007	3:45	3.7	204.6	42.2	81	29.35	0
12/18/2007	3:50	4	197.2	42.1	81.3	29.35	0
12/18/2007	3:55	4.2	188.5	42.2	81.6	29.35	0
12/18/2007	4:00	4.2	193.5	42.2	81.8	29.35	0
12/18/2007	4:05	4.1	201	42.2	82.1	29.35	0
12/18/2007	4:10	4.1	207.1	42.2	82.4	29.35	0
12/18/2007	4:15	4.8	202.5	42.2	82.6	29.35	0
12/18/2007	4:20	4.6	197.5	42.3	82.8	29.35	0
12/18/2007	4:25	4.3	200.4	42.2	83	29.34	0
12/18/2007	4:30	4.8	207.2	42.3	83.3	29.34	0
12/18/2007	4:35	5.2	210.8	42.3	83.4	29.34	0
12/18/2007	4:40	5.8	208.9	42.4	83.6	29.34	0
12/18/2007	4:45	4.8	204.8	42.4	83.6	29.34	0
12/18/2007	4:50	4.6	202.3	42.4	83.9	29.34	0
12/18/2007	4:55	4.8	211.6	42.5	84	29.34	0
12/18/2007	5:00	4	211.6	42.5	84.2	29.34	0
12/18/2007	5:05	4	211.8	42.5	84.5	29.34	0
12/18/2007	5:10	3.7	207.9	42.5	84.7	29.34	0
12/18/2007	5:15	4.1	206.3	42.5	84.8	29.35	0
12/18/2007	5:20	3.2	210.7	42.5	85	29.35	0
12/18/2007	5:25	3.6	209.7	42.5	85.3	29.34	0
12/18/2007	5:30	3.9	207.9	42.5	85.3	29.34	0
12/18/2007	5:35	3.9	214.8	42.5	85.4	29.34	0
12/18/2007	5:40	3.5	213.4	42.6	85.5	29.34	0
12/18/2007	5:45	3.2	216	42.5	85.7	29.35	0
12/18/2007	5:50	3.1	220.9	42.5	85.9	29.35	0
12/18/2007	5:55	2.8	236	42.5	85.9	29.35	0
12/18/2007	6:00	2.8	244.1	42.4	86.2	29.35	0
12/18/2007	6:05	2.4	238.1	42.3	86.4	29.35	0
12/18/2007	6:10	2.6	216	42.1	86.6	29.35	0
12/18/2007	6:15	3.5	216.1	42	87.2	29.34	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/18/2007	6:20	3.2	209.3	42.2	87.2	29.34	0
12/18/2007	6:25	2.1	222.9	42.2	87.1	29.34	0
12/18/2007	6:30	2.4	211.5	42.2	87.3	29.34	0
12/18/2007	6:35	2.4	225.9	42.3	87.3	29.35	0
12/18/2007	6:40	1.9	228.6	42.3	87.2	29.35	0
12/18/2007	6:45	2.4	230.9	42.2	87.3	29.35	0
12/18/2007	6:50	2.2	218.6	42.1	87.3	29.35	0
12/18/2007	6:55	1.9	229.2	41.9	87.6	29.35	0
12/18/2007	7:00	1.5	212.9	41.8	87.9	29.35	0
12/18/2007	7:05	1.9	201.6	41.8	88.3	29.35	0
12/18/2007	7:10	2	207.8	41.8	88.3	29.35	0
12/18/2007	7:15	2.8	214.3	41.9	88.4	29.35	0
12/18/2007	7:20	2.1	205.8	42.1	88.1	29.35	0
12/18/2007	7:25	2.7	209	42.2	88.1	29.35	0
12/18/2007	7:30	3.6	210.6	42.4	87.8	29.35	0
12/18/2007	7:35	3.6	211.2	42.6	87.5	29.35	0
12/18/2007	7:40	3.5	206.5	42.9	87	29.35	0
12/18/2007	7:45	3.1	221.9	43.1	86.7	29.35	0
12/18/2007	7:50	2.6	219.1	43.4	86.2	29.35	0
Sampling During Soil Removal (Tuesday)							
12/18/2007	7:55	2.3	201.5	43.5	85.9	29.35	0
12/18/2007	8:00	3.3	212.5	43.7	85.9	29.35	0
12/18/2007	8:05	4.6	215.1	44.1	85.2	29.35	0
12/18/2007	8:10	5.3	216.2	44.7	84	29.35	0
12/18/2007	8:15	5.1	217	45.3	82.9	29.35	0
12/18/2007	8:20	5.9	219.3	45.8	81.9	29.35	0
12/18/2007	8:25	5.6	220.1	46.3	80.9	29.34	0
12/18/2007	8:30	6	219.8	46.9	79.3	29.34	0
12/18/2007	8:35	6.2	222	47.7	77.7	29.35	0
12/18/2007	8:40	5.9	222.6	48.2	76.6	29.35	0
12/18/2007	8:45	6	223.8	48.5	75.9	29.35	0
12/18/2007	8:50	5.5	224.2	48.9	74.8	29.35	0
12/18/2007	8:55	5.5	223	49.3	73.7	29.35	0
12/18/2007	9:00	6.1	226.6	49.7	72.6	29.36	0
12/18/2007	9:05	5.6	219	50.1	72	29.36	0
12/18/2007	9:10	5.9	218.2	50.4	71.1	29.36	0
12/18/2007	9:15	6.2	219	50.7	70.4	29.37	0
12/18/2007	9:20	6.4	217.9	51.1	69.7	29.37	0
12/18/2007	9:25	6	223.6	51.2	69.6	29.36	0
12/18/2007	9:30	6.5	209.7	51.5	68.6	29.36	0
12/18/2007	9:35	7.5	220.9	52	66	29.36	0
12/18/2007	9:40	7.8	218.2	52.7	64.3	29.36	0
12/18/2007	9:45	7.7	231.2	53.4	62.9	29.36	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/18/2007	9:50	7.1	225.3	53.9	61.3	29.37	0
12/18/2007	9:55	8.1	229.3	54.2	60.5	29.37	0
12/18/2007	10:00	7.1	227	54.5	60.1	29.37	0
12/18/2007	10:05	7.5	218	54.6	60.2	29.37	0
12/18/2007	10:10	7.4	220.8	54.6	60	29.37	0
12/18/2007	10:15	6.4	222.6	54.9	59.4	29.37	0
12/18/2007	10:20	7	223.5	55.1	59.1	29.37	0
12/18/2007	10:25	6.5	222.3	55.3	59	29.36	0
12/18/2007	10:30	6.4	229	55.8	57.6	29.36	0
12/18/2007	10:35	5.6	222.4	56.4	56.4	29.37	0
12/18/2007	10:40	6.1	221.2	56.9	54.4	29.37	0
12/18/2007	10:45	6.8	219.6	57.5	53	29.37	0
12/18/2007	10:50	7	226.1	57.9	51.9	29.36	0
12/18/2007	10:55	7.5	221.7	58.2	50.5	29.37	0
12/18/2007	11:00	5.1	222.8	58.8	50.2	29.37	0
12/18/2007	11:05	5.9	217	59.4	49.5	29.37	0
12/18/2007	11:10	4.7	222.4	59.8	48.9	29.37	0
12/18/2007	11:15	4.5	220.4	60.4	47.1	29.36	0
12/18/2007	11:20	4.6	218.7	60.8	45.9	29.36	0
12/18/2007	11:25	6.3	225.5	61.5	44.7	29.36	0
12/18/2007	11:30	7.5	223.4	61.5	44.1	29.35	0
12/18/2007	11:35	5.6	220.7	61.8	44.1	29.35	0
12/18/2007	11:40	5.6	228.2	62.5	43.4	29.35	0
12/18/2007	11:45	6.9	220.1	62.8	42.1	29.35	0
12/18/2007	11:50	6.4	222.7	63.1	41.2	29.35	0
12/18/2007	11:55	6.2	221.8	63.6	40.2	29.34	0
12/18/2007	12:00	6.2	216.3	63.9	39.6	29.34	0
12/18/2007	12:05	6.9	226.9	64.2	39.2	29.34	0
12/18/2007	12:10	6.9	225.8	64.3	39.1	29.34	0
12/18/2007	12:15	5.4	224.2	64.8	38.6	29.33	0
12/18/2007	12:20	7.3	228.7	65.2	38.1	29.33	0
12/18/2007	12:25	6.1	222.1	65.5	37.8	29.33	0
12/18/2007	12:30	4.7	221.7	66.1	37.2	29.32	0
12/18/2007	12:35	6.8	216.4	66.4	36.8	29.32	0
12/18/2007	12:40	6.5	219.4	66.2	36.9	29.32	0
12/18/2007	12:45	7	225.9	66.2	36.6	29.31	0
12/18/2007	12:50	6.4	221.7	66.5	35.6	29.31	0
12/18/2007	12:55	5.4	223.8	67.1	35.2	29.31	0
12/18/2007	13:00	5.4	224.1	67.5	34.5	29.31	0
12/18/2007	13:05	5	229.9	68	33.7	29.31	0
12/18/2007	13:10	5.8	216.5	68.3	32.9	29.31	0
12/18/2007	13:15	5.8	219.8	68.5	32.7	29.31	0
12/18/2007	13:20	5	224.9	68.9	32	29.31	0
12/18/2007	13:25	4.8	220.1	69.5	30.9	29.3	0
12/18/2007	13:30	7.3	224.6	69.6	30.7	29.3	0
12/18/2007	13:35	6.8	224.6	69.6	30.4	29.3	0
12/18/2007	13:40	6.8	222.3	69.8	29.6	29.29	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/18/2007	13:45	7.2	222	69.9	29.7	29.29	0
12/18/2007	13:50	7.9	223.2	69.9	29.4	29.29	0
12/18/2007	13:55	5.9	219.9	70.1	28.6	29.29	0
12/18/2007	14:00	6.6	226.6	70.6	28.3	29.28	0
12/18/2007	14:05	6.9	225.1	70.9	28	29.28	0
12/18/2007	14:10	6	220.8	71.1	27.5	29.28	0
12/18/2007	14:15	4.8	225.3	71.6	27	29.28	0
12/18/2007	14:20	4.1	221.7	72.4	26.4	29.28	0
12/18/2007	14:25	6.6	222.6	72.4	26.2	29.28	0
12/18/2007	14:30	4.1	226.5	72.3	26.1	29.28	0
12/18/2007	14:35	4.9	222.6	72.8	25.7	29.28	0
12/18/2007	14:40	4.5	224	73.2	25.6	29.28	0
12/18/2007	14:45	4.9	221.2	73.1	25.6	29.28	0
12/18/2007	14:50	6	225.9	73	25.6	29.28	0
12/18/2007	14:55	5.7	223	73	25.4	29.28	0
12/18/2007	15:00	3.3	232.8	73.3	25.1	29.28	0
12/18/2007	15:05	5	220.4	73.7	24.4	29.28	0
12/18/2007	15:10	4.9	220.5	73.8	24	29.28	0
12/18/2007	15:15	6	222.7	73.7	24.1	29.28	0
12/18/2007	15:20	5.4	226.3	73.7	24.4	29.28	0
12/18/2007	15:25	6.2	227.1	73.6	24.2	29.28	0
12/18/2007	15:30	5.9	222.4	73.6	23.9	29.29	0
12/18/2007	15:35	4.5	221.6	73.7	23.7	29.29	0
12/18/2007	15:40	3.5	220.2	74.4	22.7	29.29	0
12/18/2007	15:45	4.1	216.4	74.6	23.1	29.29	0
12/18/2007	15:50	4.1	226.5	74.6	23.4	29.29	0
12/18/2007	15:55	4.1	220.3	74.4	23.5	29.3	0
12/18/2007	16:00	4.7	222.5	74.2	23.9	29.3	0
12/18/2007	16:05	4.4	223.4	73.9	24.1	29.3	0
12/18/2007	16:10	2.5	221.2	74.1	24.2	29.3	0
12/18/2007	16:15	2.2	215.6	74.5	23.7	29.3	0
12/18/2007	16:20	2.1	232.1	74.5	23.9	29.3	0
12/18/2007	16:25	2.6	231.4	73.9	23.1	29.31	0
12/18/2007	16:30	3.9	217.5	73.2	22.1	29.31	0
12/18/2007	16:35	2.4	230.8	72.5	22.8	29.31	0
12/18/2007	16:40	3.5	216.3	71.5	23.1	29.32	0
12/18/2007	16:45	3.4	225.2	71.1	23.5	29.31	0
12/18/2007	16:50	3.3	222.8	70.8	23.7	29.31	0
12/18/2007	16:55	3.3	227.2	70.5	24.2	29.32	0
12/18/2007	17:00	3	221.2	70.2	24.6	29.31	0
12/18/2007	17:05	3.8	225.3	69.9	24.8	29.32	0
12/18/2007	17:10	2.4	224.7	69.6	25.5	29.32	0
12/18/2007	17:15	2.4	222.8	68.9	26.6	29.32	0
12/18/2007	17:20	1.5	210.4	68.2	27.6	29.33	0
12/18/2007	17:25	1.2	195.6	67.4	28.9	29.33	0
12/18/2007	17:30	1.6	209	66.6	30.3	29.33	0
12/18/2007	17:35	1.4	209.2	65.9	31.4	29.33	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/18/2007	17:40	1.7	213.9	65.1	32.8	29.33	0
12/18/2007	17:45	2.1	217.1	64.3	33.8	29.33	0
12/18/2007	17:50	1.9	215.3	63.9	33.6	29.33	0
12/18/2007	17:55	1.7	216.5	63.6	34.4	29.33	0
12/18/2007	18:00	0.9	176.6	63.1	35.2	29.33	0
12/18/2007	18:05	0.8	168.1	62.3	36.2	29.33	0
12/18/2007	18:10	0.8	182.3	61.5	37.4	29.34	0
12/18/2007	18:15	0.8	199.5	61	38.6	29.34	0
12/18/2007	18:20	0.8	161.4	60.5	39.6	29.34	0
12/18/2007	18:25	0.8	149.7	60	40.1	29.34	0
12/18/2007	18:30	0.8	205.6	59.7	40.5	29.34	0
Max		8.1	232.8	74.6	85.9	29.37	0
Min		0.8	149.7	43.5	22.1	29.28	0
Mean		5.0	219.2	63.4	42.3	29.33	0
12/18/2007	18:35	0.8	200.9	59.5	40.7	29.34	0
12/18/2007	18:40	0.8	57.9	59.1	42.5	29.34	0
12/18/2007	18:45	0.9	147.5	58.5	43.2	29.35	0
12/18/2007	18:50	0.8	195.3	58.1	43.8	29.35	0
12/18/2007	18:55	1	210.1	58	43.6	29.35	0
12/18/2007	19:00	0.8	123.5	57.7	44.1	29.35	0
12/18/2007	19:05	0.8	175.8	57.2	44.6	29.35	0
12/18/2007	19:10	0.8	158.6	56.9	44.2	29.35	0
12/18/2007	19:15	0.9	195	56.9	42.9	29.35	0
12/18/2007	19:20	0.8	168.2	57.1	40.6	29.35	0
12/18/2007	19:25	0.8	207	57.2	38.6	29.36	0
12/18/2007	19:30	0.8	148.9	57.5	37.5	29.36	0
12/18/2007	19:35	1	202.6	57.6	36.4	29.36	0
12/18/2007	19:40	1.4	219.8	57.9	36.4	29.36	0
12/18/2007	19:45	1	48.1	57.9	37.1	29.36	0
12/18/2007	19:50	0.9	344.9	57.7	38	29.37	0
12/18/2007	19:55	0.8	238.5	57.2	38.9	29.37	0
12/18/2007	20:00	1.2	137	56.5	39.4	29.37	0
12/18/2007	20:05	1.1	8.2	56.6	38.8	29.37	0
12/18/2007	20:10	0.9	85.6	56.7	38.6	29.37	0
12/18/2007	20:15	0.8	120.4	56.3	40.2	29.37	0
12/18/2007	20:20	0.8	68.3	55.7	40.6	29.37	0
12/18/2007	20:25	0.8	50.1	55.2	41.2	29.37	0
12/18/2007	20:30	1	18.7	55	41.1	29.37	0
12/18/2007	20:35	0.8	54.6	54.9	41.6	29.38	0
12/18/2007	20:40	0.8	49.8	54.7	41.4	29.38	0
12/18/2007	20:45	1	52.8	54.6	42.1	29.38	0
12/18/2007	20:50	1.2	50.8	54.4	42.6	29.38	0
12/18/2007	20:55	0.8	78.2	54.1	43.5	29.38	0
12/18/2007	21:00	1	48.2	53.6	44.3	29.38	0
12/18/2007	21:05	1.4	47	53.4	44.9	29.38	0
12/18/2007	21:10	1.1	50.6	53.1	45.9	29.38	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/18/2007	21:15	0.8	64.9	52.7	46.5	29.38	0
12/18/2007	21:20	0.8	78.6	52.2	47.5	29.38	0
12/18/2007	21:25	0.8	114.6	51.6	48.7	29.38	0
12/18/2007	21:30	0.8	55.8	51.2	49.7	29.39	0
12/18/2007	21:35	0.8	48.3	50.9	50.1	29.39	0
12/18/2007	21:40	0.8	41.9	50.7	50.8	29.39	0
12/18/2007	21:45	0.8	39	50.2	51.4	29.39	0
12/18/2007	21:50	0.8	186.7	49.7	53.1	29.39	0
12/18/2007	21:55	0.8	199	49.4	53.4	29.39	0
12/18/2007	22:00	0.8	111.4	49.1	55.1	29.39	0
12/18/2007	22:05	0.7	43.9	48.8	56.2	29.39	0
12/18/2007	22:10	0.8	161.2	48.4	56.5	29.39	0
12/18/2007	22:15	0.8	196	48.2	57	29.39	0
12/18/2007	22:20	0.7	200.1	48.1	57.9	29.39	0
12/18/2007	22:25	0.8	185.2	48.1	57.4	29.39	0
12/18/2007	22:30	0.8	195.7	48.1	57.1	29.4	0
12/18/2007	22:35	1	211.6	48.2	56.9	29.4	0
12/18/2007	22:40	0.8	187.3	48.2	57.4	29.4	0
12/18/2007	22:45	0.8	120.7	47.9	58	29.4	0
12/18/2007	22:50	0.8	133.3	47.4	59.2	29.4	0
12/18/2007	22:55	0.8	175.8	47.2	59.4	29.39	0
12/18/2007	23:00	0.8	183.4	47.2	58.7	29.39	0
12/18/2007	23:05	0.8	172.2	47	59.3	29.39	0
12/18/2007	23:10	0.8	156.1	47	59.5	29.39	0
12/18/2007	23:15	1	206.8	47.1	58.7	29.39	0
12/18/2007	23:20	0.8	201.7	47.1	59.1	29.4	0
12/18/2007	23:25	0.7	119.3	46.8	60.1	29.4	0
12/18/2007	23:30	0.8	21.9	46.7	59.6	29.39	0
12/18/2007	23:35	0.8	179.5	46.6	60	29.4	0
12/18/2007	23:40	0.8	155	46.5	59.9	29.4	0
12/18/2007	23:45	0.8	111.1	46.3	60.2	29.4	0
12/18/2007	23:50	0.8	86.1	46.2	60.4	29.39	0
12/18/2007	23:55	0.9	74.8	46.3	60.2	29.39	0
12/18/2007	24:00:00	0.8	101.8	46.3	60.2	29.39	0
12/19/2007	0:05	0.8	97	46.1	60.7	29.39	0
12/19/2007	0:10	1	62.4	45.9	61	29.38	0
12/19/2007	0:15	1.6	44.9	45.8	61.1	29.38	0
12/19/2007	0:20	1	81.7	45.7	61.5	29.38	0
12/19/2007	0:25	0.8	131.6	45.3	62.1	29.38	0
12/19/2007	0:30	0.8	165.5	44.8	63.4	29.38	0
12/19/2007	0:35	0.8	139.3	44.4	64.4	29.38	0
12/19/2007	0:40	0.8	103.7	44.3	64.9	29.37	0
12/19/2007	0:45	0.8	125	44.1	65.2	29.37	0
12/19/2007	0:50	0.8	196.4	44	64.9	29.37	0
12/19/2007	0:55	0.8	199.1	44.1	64.7	29.37	0
12/19/2007	1:00	0.8	190.5	44	64.9	29.37	0
12/19/2007	1:05	0.9	202.4	44	65.1	29.36	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/19/2007	1:10	0.8	201.9	44.1	64.9	29.36	0
12/19/2007	1:15	0.8	181.7	43.9	65.2	29.36	0
12/19/2007	1:20	0.8	171.1	43.7	65.7	29.36	0
12/19/2007	1:25	0.8	160.5	43.5	65.9	29.36	0
12/19/2007	1:30	0.8	156	43.5	65.4	29.36	0
12/19/2007	1:35	0.9	204.6	43.5	65.2	29.36	0
12/19/2007	1:40	1.6	212.4	43.7	65.4	29.37	0
12/19/2007	1:45	1.1	212	43.9	65	29.37	0
12/19/2007	1:50	0.9	207.2	43.9	65.1	29.37	0
12/19/2007	1:55	1	215.7	43.8	65.4	29.37	0
12/19/2007	2:00	0.9	209.4	43.6	65.6	29.37	0
12/19/2007	2:05	0.8	199.6	43.5	66	29.37	0
12/19/2007	2:10	0.8	183.5	43.3	66.5	29.37	0
12/19/2007	2:15	0.8	183.8	42.9	66.8	29.37	0
12/19/2007	2:20	0.7	114.7	42.6	68	29.37	0
12/19/2007	2:25	0.8	121	42.5	67.8	29.37	0
12/19/2007	2:30	0.8	80.9	42.5	67.4	29.37	0
12/19/2007	2:35	0.8	95.6	42.7	67.1	29.37	0
12/19/2007	2:40	0.8	199	42.8	66.7	29.37	0
12/19/2007	2:45	0.8	156.9	42.7	67	29.37	0
12/19/2007	2:50	0.8	68	42.5	68.2	29.37	0
12/19/2007	2:55	0.8	109.9	42.4	68.7	29.37	0
12/19/2007	3:00	1	28	42.3	69.2	29.37	0
12/19/2007	3:05	1.1	48.9	42.3	69.5	29.37	0
12/19/2007	3:10	1	34.9	42.1	69.9	29.37	0
12/19/2007	3:15	0.8	94.8	42	70	29.37	0
12/19/2007	3:20	0.8	36.6	41.7	70.7	29.37	0
12/19/2007	3:25	0.8	178.5	41.4	71.2	29.37	0
12/19/2007	3:30	0.8	182.5	41.1	72.1	29.37	0
12/19/2007	3:35	0.8	191.1	40.8	72.6	29.37	0
12/19/2007	3:40	0.8	194.6	40.6	72.9	29.37	0
12/19/2007	3:45	0.8	164.2	40.5	73.8	29.36	0
12/19/2007	3:50	0.8	168.1	40.5	73.4	29.36	0
12/19/2007	3:55	0.8	128.4	40.4	74	29.36	0
12/19/2007	4:00	0.8	111.1	40.3	74.5	29.36	0
12/19/2007	4:05	1.3	32.5	40.4	74.8	29.36	0
12/19/2007	4:10	0.8	97	40.5	73.5	29.35	0
12/19/2007	4:15	0.8	119.6	40.4	73.5	29.35	0
12/19/2007	4:20	0.8	119.6	40.2	73.9	29.35	0
12/19/2007	4:25	0.8	178.2	40	74	29.36	0
12/19/2007	4:30	0.7	201.8	40	74.1	29.36	0
12/19/2007	4:35	0.8	184.2	40	74.2	29.36	0
12/19/2007	4:40	0.8	196.8	40.1	74	29.36	0
12/19/2007	4:45	0.8	200.4	39.9	74	29.35	0
12/19/2007	4:50	0.8	199.4	39.8	74.1	29.35	0
12/19/2007	4:55	0.8	42.7	39.8	74.5	29.35	0
12/19/2007	5:00	1.2	258.4	39.9	74.5	29.35	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/19/2007	5:05	1	86	39.9	74.3	29.35	0
12/19/2007	5:10	0.8	9.6	39.9	74.6	29.35	0
12/19/2007	5:15	0.8	34.3	39.8	74.8	29.35	0
12/19/2007	5:20	0.8	54.9	39.7	74.8	29.35	0
12/19/2007	5:25	1.3	240.3	39.7	74.7	29.35	0
12/19/2007	5:30	0.8	191.3	39.6	74.3	29.35	0
12/19/2007	5:35	1.4	212.5	39.6	74.8	29.35	0
12/19/2007	5:40	1.3	225.7	39.6	75.2	29.36	0
12/19/2007	5:45	0.9	217.1	39.6	75.3	29.36	0
12/19/2007	5:50	0.9	204.9	39.4	75.6	29.37	0
12/19/2007	5:55	1	160.1	39.4	75.6	29.36	0
12/19/2007	6:00	0.9	119.9	39.3	75.1	29.35	0
12/19/2007	6:05	0.9	308.6	39.2	75.3	29.36	0
12/19/2007	6:10	0.7	160.3	39.1	75.7	29.36	0
12/19/2007	6:15	0.8	197.4	38.9	76	29.36	0
12/19/2007	6:20	0.7	196.4	38.9	75.9	29.36	0
12/19/2007	6:25	0.8	195.3	38.8	76.2	29.35	0
12/19/2007	6:30	0.8	142.1	38.8	76.4	29.35	0
12/19/2007	6:35	0.8	45.5	38.8	76.5	29.35	0
12/19/2007	6:40	0.8	63.3	38.9	76.2	29.35	0
12/19/2007	6:45	0.8	64.1	38.8	76.7	29.35	0
12/19/2007	6:50	0.8	176.1	38.8	76.7	29.35	0
12/19/2007	6:55	0.8	169.1	38.7	77	29.35	0
12/19/2007	7:00	0.8	192.8	38.7	77.1	29.35	0
12/19/2007	7:05	0.8	200.7	38.7	77	29.36	0
12/19/2007	7:10	0.7	205.8	38.6	77	29.36	0
12/19/2007	7:15	0.8	197.1	38.6	77.1	29.36	0
12/19/2007	7:20	0.8	196.4	38.7	77.2	29.35	0
12/19/2007	7:25	0.7	186.5	38.7	76.8	29.35	0
12/19/2007	7:30	0.8	250	38.7	76.7	29.36	0
12/19/2007	7:35	0.8	202	38.8	76.1	29.36	0
Worker Sampling During Pavement Washing (Wednesday)							
12/19/2007	7:40	0.8	196.1	39	75.7	29.37	0
12/19/2007	7:45	1	191.7	39.1	75.2	29.36	0
12/19/2007	7:50	0.9	170	39.4	74.8	29.36	0
12/19/2007	7:55	0.8	165.8	39.6	74.4	29.36	0
12/19/2007	8:00	1.4	215.9	39.9	73.5	29.36	0
12/19/2007	8:05	1.6	206	40.1	73.7	29.36	0
12/19/2007	8:10	2	215.2	40.4	73.5	29.37	0
12/19/2007	8:15	1.9	224	40.8	72.7	29.37	0
12/19/2007	8:20	1.4	201.4	41.2	72.3	29.37	0
12/19/2007	8:25	1.9	218.8	41.4	72.3	29.37	0
12/19/2007	8:30	1	201.2	41.6	71.9	29.36	0
12/19/2007	8:35	1	348.9	41.8	71.6	29.36	0
12/19/2007	8:40	0.8	14.1	42	71.1	29.36	0
12/19/2007	8:45	1	22.9	42.2	70.8	29.36	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/19/2007	8:50	1	4.7	42.5	70.6	29.36	0
12/19/2007	8:55	1	66.5	43.1	69.5	29.36	0
12/19/2007	9:00	1.3	30.7	43.4	68.4	29.36	0
12/19/2007	9:05	1.7	356.7	43.7	67.7	29.36	0
12/19/2007	9:10	1.8	17.1	44	66.5	29.36	0
12/19/2007	9:15	1.5	21.3	44.5	65.4	29.36	0
12/19/2007	9:20	2.2	29.3	45.3	63.4	29.36	0
12/19/2007	9:25	1.5	355.2	45.5	63.6	29.37	0
12/19/2007	9:30	2	218.5	46	63.4	29.37	0
12/19/2007	9:35	1.3	28.6	46.3	61.4	29.37	0
12/19/2007	9:40	1.3	33.9	47.1	60.9	29.38	0
12/19/2007	9:45	2	192.4	47.8	59.9	29.38	0
12/19/2007	9:50	2.2	211.6	47.9	60.1	29.38	0
12/19/2007	9:55	2	220.6	48.3	59.8	29.38	0
12/19/2007	10:00	2.4	211.8	48.6	59.9	29.39	0
12/19/2007	10:05	2.9	226	49.4	57.8	29.39	0
12/19/2007	10:10	2.3	212.9	50.3	56.2	29.39	0
12/19/2007	10:15	2.3	217.6	51.3	54.1	29.39	0
12/19/2007	10:20	1.5	204	51.8	53.5	29.38	0
12/19/2007	10:25	1.5	177.1	52.2	53.5	29.38	0
12/19/2007	10:30	2.6	144	52.8	53.2	29.38	0
12/19/2007	10:35	1.7	178	53.1	53.3	29.38	0
12/19/2007	10:40	1.9	141.8	53.5	53.3	29.38	0
12/19/2007	10:45	2	180.7	53.7	52.9	29.38	0
12/19/2007	10:50	1.6	143.8	54.3	52.1	29.38	0
12/19/2007	10:55	1.7	142.3	55	51	29.37	0
12/19/2007	11:00	1.9	208.4	55.6	50.3	29.38	0
12/19/2007	11:05	3.3	211.6	56.1	49.4	29.38	0
12/19/2007	11:10	4.3	216.8	56.2	48.6	29.38	0
12/19/2007	11:15	3	173.1	56.3	48.4	29.38	0
12/19/2007	11:20	3.2	199.1	56.9	47.4	29.37	0
12/19/2007	11:25	2.7	205.9	57.7	45.7	29.37	0
12/19/2007	11:30	3.2	215	58	45.8	29.36	0
12/19/2007	11:35	3	213.8	58.3	45.7	29.35	0
12/19/2007	11:40	3.2	216.5	58.7	44.6	29.35	0
12/19/2007	11:45	3.3	214	58.7	44.3	29.35	0
12/19/2007	11:50	3.3	222.3	58.8	44.6	29.35	0
12/19/2007	11:55	2.8	229.4	58.5	45.5	29.34	0
12/19/2007	12:00	2.5	151.7	58.3	46.3	29.34	0
12/19/2007	12:05	2.6	140.6	58.3	45.8	29.33	0
12/19/2007	12:10	2.9	199.7	58.2	45.5	29.33	0
12/19/2007	12:15	2.9	217.2	58.9	45	29.33	0
12/19/2007	12:20	3	208.3	59.7	44.1	29.32	0
12/19/2007	12:25	1.8	140.2	60.6	43.3	29.31	0
12/19/2007	12:30	2.2	181.3	61	43.3	29.31	0
12/19/2007	12:35	3.3	162.6	61.2	42.9	29.31	0
12/19/2007	12:40	3.4	196	60.9	43.5	29.31	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/19/2007	12:45	3.2	190.3	60.6	44.3	29.3	0
12/19/2007	12:50	3.2	202.8	60.6	44.3	29.3	0
12/19/2007	12:55	4.3	209.8	60.9	43.5	29.3	0
12/19/2007	13:00	3.9	196.1	61.6	42.5	29.3	0
12/19/2007	13:05	3.2	188	62.3	41.5	29.29	0
12/19/2007	13:10	3.3	200.9	62.7	40.8	29.29	0
12/19/2007	13:15	3.5	193.7	63	40.5	29.28	0
12/19/2007	13:20	2.9	198	63.6	39.8	29.28	0
12/19/2007	13:25	4.2	194.2	64.3	39.3	29.28	0
12/19/2007	13:30	3.3	189.8	64.2	39.7	29.28	0
12/19/2007	13:35	3.7	193	64.6	39.2	29.27	0
12/19/2007	13:40	3.7	226.9	64.9	39.1	29.27	0
12/19/2007	13:45	3	203.4	65.7	38.2	29.26	0
12/19/2007	13:50	2.9	217	66.6	37.5	29.26	0
12/19/2007	13:55	2.7	174.2	66.7	38	29.25	0
12/19/2007	14:00	3	167.2	66.7	38.1	29.26	0
12/19/2007	14:05	3	180.4	67.1	37.8	29.25	0
12/19/2007	14:10	3.7	187.5	67.3	37.7	29.25	0
12/19/2007	14:15	3.2	192.4	67.2	38	29.25	0
12/19/2007	14:20	3.6	184	67.2	38	29.25	0
12/19/2007	14:25	3.7	189.3	67.1	38.1	29.25	0
12/19/2007	14:30	4.1	196.4	67.2	38	29.24	0
12/19/2007	14:35	3.6	191.6	67.1	38.5	29.24	0
12/19/2007	14:40	3.5	198.6	66.8	39.4	29.24	0
12/19/2007	14:45	3.1	193.4	67.1	39.2	29.24	0
12/19/2007	14:50	3.2	182.6	67.6	38.7	29.23	0
12/19/2007	14:55	3.2	147.5	67.6	39.1	29.23	0
12/19/2007	15:00	3.1	176.1	67	40.2	29.23	0
12/19/2007	15:05	3.2	175.1	66.9	40	29.22	0
12/19/2007	15:10	3.2	167.7	66.9	40.3	29.22	0
12/19/2007	15:15	3.4	125.4	67	40.5	29.22	0
12/19/2007	15:20	3.9	161.3	66.6	41.3	29.21	0
12/19/2007	15:25	3.1	187.2	66.3	41.9	29.21	0
12/19/2007	15:30	2.5	176.7	66.9	41.4	29.2	0
12/19/2007	15:35	2.9	172.7	67.1	41.3	29.2	0
12/19/2007	15:40	2.9	144.7	67.1	41.9	29.2	0
12/19/2007	15:45	3.1	160.6	66.9	42.3	29.2	0
12/19/2007	15:50	2.7	173.7	67.2	41.9	29.2	0
12/19/2007	15:55	3	184.2	67.4	42.2	29.21	0
12/19/2007	16:00	3.4	186.1	67.2	42.5	29.21	0
12/19/2007	16:05	3.9	192	67.1	43.3	29.21	0
12/19/2007	16:10	3.6	201.2	66.8	44.4	29.21	0
12/19/2007	16:15	3	193.1	66.7	45	29.22	0
12/19/2007	16:20	3.2	203.7	66.6	45.7	29.21	0
12/19/2007	16:25	2.8	213.8	66.5	46.4	29.21	0
12/19/2007	16:30	2.9	202.1	66.2	47.4	29.21	0
12/19/2007	16:35	3.8	195.6	66	49.1	29.2	0

Date	Time	Wind Speed, mph	Wind Direction, deg	Air Temp, deg F	Relative Humidity, %	Barometric Pressure, in Hg	Rainfall, in
12/19/2007	16:40	4	189.2	65.9	50.4	29.2	0
Max		4.3	356.7	67.6	75.7	29.39	0
Min		0.8	4.7	39	37.5	29.2	0
Mean		2.6	179.9	56.8	50.6	29.3	0

TABLE 13-2. SAMPLE KEY

Label Category	Label ID	ID Description	Relevant Media
MEDIA	AIR	Air	NA
	WATER	Water	NA
	SOIL	Soil	NA
	SDUST	Settled Dust	NA
LOCATION/ BUILDING	PC	Popcorn Ceiling Building	ALL
PUMP FLOW RATE	4L	Target Air Flow Rate: 4 LPM	Air
	2L	Target Air Flow Rate: 2 LPM	Air
	8L	Target Air Flow Rate: 8 LPM	Air
TIME	AM	Morning (between 0600-1200 hours)	Water
	PM	Afternoon (after 1200 hours)	Water
	PRE	Pre- (Building) Demolition	All
	POST	Post- (Building) Demolition	All
	W	During Wetting of PC Building	Air, Settled Dust
	D	During Demolition of PC Building	Air, Settled Dust
	DEX	During Excavation	Air, Settled Dust
	DCL	During Cleaning	Air, Settled Dust
RING SAMPLER NUMBER	MO	Monitoring Station Number in Perimeter Ring	Air, Settled Dust
LAB DESIGNATION	RD	Verification Counting	
	RP	Duplicate Analysis	
	RS	Replicate Analysis	
	LB	Lab Blank	
	VA	Verification Count	
	NRA	Non-Regulated Asbestos	

Table 13-3. AIRBORNE ASBESTOS AND TOTAL FIBERS DURING PRE-WETTING (PERIMETER AIR)

Sample Number	Sample Volume, Liters	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM)[2], s/cm³				Total Fibers (PCM), f/cm³
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME	
PC-PERIMETERAIR-M01-2L-W	1612	49	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
PC-PERIMETERAIR-M02-2L-W	1700	47	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0011
PC-PERIMETERAIR-M03-2L-W	1556	51	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0014
PC-PERIMETERAIR-M03-2L-W-DUP	1638	49	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0056
PC-PERIMETERAIR-M04-2L-W	1573	50	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0035
PC-PERIMETERAIR-M05-2L-W	1593	50	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0027
PC-PERIMETERAIR-M06-2L-W	1570	51	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
PC-PERIMETERAIR-M07-2L-W	1593	50	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0023
PC-PERIMETERAIR-M08-2L-W	1596	50	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
PC-PERIMETERAIR-M09-2L-W	1596	50	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0026
PC-PERIMETERAIR-M10-2L-W	1564	51	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0031
PC-PERIMETERAIR-M11-2L-W	1536	52	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0019
PC-PERIMETERAIR-M12-2L-W	1552	51	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0017
PC-PERIMETERAIR-M12-2L-W-DUP	1519	52	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0013
PC-PERIMETERAIR-M13-2L-W	1540	52	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0013
PC-PERIMETERAIR-M14-2L-W	1645	48	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
PC-PERIMETERAIR-M15-2L-W	1585	50	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0023
PC-PERIMETERAIR-M16-2L-W	1559	51	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0018
PC-PERIMETERAIR-M17-2L-W	1610	49	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0013
PC-PERIMETERAIR-M18-2L-W	1565	51	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0017
PC-PERIMETERAIR-W-BL	0	10	0	0	--	--	--	--	--
PC-PERIMETERAIR-W-BL	0	10	0	0	--	--	--	--	--
Background									
BG-AIR-BG01-2L-W	1667	48	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0016
BG-AIR-BG02-2L-W	1638	49	3	0	0.0015	<0.00048	0.0015	<0.00048	<0.0012
BG-AIR-BG03-2L-W	1662	48	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
BG-AIR-BG04-2L-W	1661	48	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
BG-AIR-BG04-2L-W-DUP	1706	47	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0020
BG-AIR-BG05-2L-W	1710	46	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0011
BG-AIR-BG06-2L-W	1685	47	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0021
BG-AIR-W-BL	0	10	0	0	--	--	--	--	--

[1]Grid opening size = 0.0099mm²; effective filter area = 385 mm².
[2]Less than values represent the analytical sensitivities; detection limits are 2.99 times higher, per ISO 10312.

TABLE 13-4. AIRBORNE ASBESTOS AND TOTAL FIBERS DURING DEMOLITION (PERIMETER AIR)

Sample Number	Sample Volume, Liters	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM), s/cm^3				Total Fibers (PCM), f/cm^3
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME	
PC-PERIMETERAIR-M01-4L-D	3097	21	1	0	0.00049	<0.00049	0.00049	<0.00049	0.0007
PC-PERIMETERAIR-M02-4L-D	3099	21	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0006
PC-PERIMETERAIR-M02-2L-D*	1571	42	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0012
PC-PERIMETERAIR-M03-4L-D	3099	21	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0047
PC-PERIMETERAIR-M04-4L-D	3071	22	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0053
PC-PERIMETERAIR-M05-4L-D	3098	21	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0011
PC-PERIMETERAIR-M06-4L-D	3038	22	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0035
PC-PERIMETERAIR-M07-4L-D	2994	22	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0052
PC-PERIMETERAIR-M08-4L-D	2975	22	3	0	0.0015	<0.00049	0.0015	<0.00049	0.0011
PC-PERIMETERAIR-M08-4L-D-DUP	3017	22	7	0	0.0034	<0.00048	0.0034	<0.00048	0.0046
PC-PERIMETERAIR-M09-4L-D	2995	22	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0007
PC-PERIMETERAIR-M10-4L-D	3000	22	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0015
PC-PERIMETERAIR-M11-4L-D	3104	21	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0023
PC-PERIMETERAIR-M12-4L-D	3118	21	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0024
PC-PERIMETERAIR-M13-4L-D	3006	22	4	0	0.0019	<0.00048	0.0019	<0.00048	0.0016
PC-PERIMETERAIR-M14-4L-D	3223	21	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0025
PC-PERIMETERAIR-M15-4L-D	3075	22	1	0	0.00047	<0.00047	0.00047	<0.00047	0.0018
PC-PERIMETERAIR-M16-4L-D	3172	21	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0024
PC-PERIMETERAIR-M16-4L-D-DUP	3024	22	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0014
PC-PERIMETERAIR-M17-4L-D	3071	22	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0013
PC-PERIMETERAIR-M18-4L-D	3077	22	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0016
Background									
BG-AIR-BG01-4L-D	2880	23	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0047
BG-AIR-BG02-4L-D	2955	23	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0025
BG-AIR-BG03-4L-D	3052	22	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0016
BG-AIR-BG04-4L-D	2944	22	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0031
BG-AIR-BG04-4L-D-DUP	2666	25	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0037
BG-AIR-BG05-4L-D	2960	23	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0009
BG-AIR-BG06-4L-D	3026	22	3	0	0.0014	<0.00048	0.0014	<0.00048	0.0018

Sample Number	Sample Volume, Liters	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM), s/cm^3				Total Fibers (PCM), f/cm^3
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME	
BG-AIR-D-BL	0	10	0	0	0	0	<3,200	0	0
BG-AIR-D-BL	0	10	0	0	0	0	<3,200	0	0
Balconies									
PC-ROOFS-R01-4L-D	2911	22	0	0	<0.00050	<0.00050	<0.00050	<0.00050	0.0015
PC-ROOFS-R02-4L-D	2900	22	0	0	<0.00050	<0.00050	<0.00050	<0.00050	0.0017
PC-ROOFS-R03-4L-D	2904	22	0	0	<0.00050	<0.00050	<0.00050	<0.00050	0.0012
PC-ROOFS-R04-4L-D	2868	23	7	0	0.0034	<0.00049	0.0034	<0.00049	0.0026
PC-ROOFS-R05-4L-D	2837	23	1	0	0.00049	<0.00049	0.00049	<0.00049	0.0015
PC-ROOFS-R06-4L-D	2886	22	0	0	<0.00050	<0.00050	<0.00050	<0.00050	0.0016
Top of Wall									
PC-BOCARATONWALL-B01-4L-D	2489	26	0	0	<.00049	<.00049	<.00049	<.00049	0.0010
PC-BOCARATONWALL-B02-4L-D	2480	27	0	0	<.00048	<.00048	<.00048	<.00048	0.0008
PC-BOCARATONWALL-B03-4L-D	2542	26	0	0	<.00048	<.00048	<.00048	<.00048	0.0009
In Front of Woodstock Apartments									
PC-WOODSTOCK-WS01-4L-D	2922	22	0	0	<0.00050	<0.00050	<0.00050	<0.00050	<0.0007
PC-WOODSTOCK-WS02-4L-D	2947	22	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0011
PC-WOODSTOCK-WS03-4L-D	2902	22	0	0	<0.00050	<0.00050	<0.00050	<0.00050	<0.0007

[1]Grid opening size = 0.0114 mm^2; effective filter area = 385 mm^2.

[2]Less than values represent the analytical sensitivities; detection limits are 2.99 times higher, per ISO 10312.

* Sample PC-PERIMETERAIR-M02-4L-D was overloaded. Sample PC-PERIMETERAIR-M02-2L-D was analyzed instead.

Table 13-5. AIRBORNE ASBESTOS AND TOTAL FIBERS DURING EXCAVATION (PERIMETER AIR)

Sample Number	Sample Volume, Liters	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM)[2], s/cm^3				Total Fibers (PCM), $fibers/cm^3$
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME	
PC-PERIMETERAIR-M01-8L-DEX	4931	14	0	0	<0.00046	<0.00046	<0.00046	<0.00046	0.0016
PC-PERIMETERAIR-M02-8L-DEX	4934	14	0	0	<0.00046	<0.00046	<0.00046	<0.00046	0.0021
PC-PERIMETERAIR-M03-8L-DEX	4911	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0033
PC-PERIMETERAIR-M04-8L-DEX	4863	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.00087
PC-PERIMETERAIR-M05-8L-DEX	4853	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.00093
PC-PERIMETERAIR-M06-8L-DEX	4865	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0022
PC-PERIMETERAIR-M07-8L-DEX	4730	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0027
PC-PERIMETERAIR-M08-8L-DEX	4863	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0016
PC-PERIMETERAIR-M08-8L-DEX-DUP	4675	14	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0018
PC-PERIMETERAIR-M09-8L-DEX	4759	14	1	0	0.00048	<0.00048	0.00048	<0.00048	0.0020
PC-PERIMETERAIR-M10-8L-DEX	4763	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0016
PC-PERIMETERAIR-M11-8L-DEX	4914	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0011
PC-PERIMETERAIR-M12-8L-DEX	4789	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0013
PC-PERIMETERAIR-M13-8L-DEX	4997	14	0	0	<0.00046	<0.00046	<0.00046	<0.00046	0.0008
PC-PERIMETERAIR-M14-8L-DEX	5031	13	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0011
PC-PERIMETERAIR-M15-8L-DEX	4823	14	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.00073
PC-PERIMETERAIR-M16-8L-DEX	4804	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	<0.00040
PC-PERIMETERAIR-M16-8L-DEX-DUP	4719	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0023
PC-PERIMETERAIR-M17-8L-DEX	4799	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0014
PC-PERIMETERAIR-M18-8L-DEX	4747	14	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0021
Background									
BG-AIR-BG01-8L-DEX	4426	15	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0023
BG-AIR-BG02-8L-DEX	4385	15	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0014
BG-AIR-BG03-8L-DEX	4372	15	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0024
BG-AIR-BG04-8L-DEX	4513	15	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0016
BG-AIR-BG04-8L-DEX-DUP	4403	15	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0019
BG-AIR-BG05-8L-DEX	4371	15	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0018
BG-AIR-BG06-8L-DEX	4277	16	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0012
BG-AIR-DEX-BL	0	10	0	0	--	--	--	--	--
BG-AIR-DEX-BL	0	10	0	0	--	--	--	--	--

[1]Grid opening size = 0.0120 mm^2; effective filter area = 385 mm^2.
[2]Less than values represent the analytical sensitivities; detection limits are 2.99 times higher, per ISO 10312.

Table 13-6. AIRBORNE ASBESTOS AND TOTAL FIBERS DURING CLEANING (PERIMETER AIR)

Sample Number	Sample Volume, Liters	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM)[2], s/cm³				Total Fibers (PCM), f/cm³
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME	
PC-PERIMETER-M01-4L-DCL	2011	34	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0026
PC-PERIMETER-M02-4L-DCL*	1864	37	0	0	<0.00049	<0.00049	<0.00049	<0.00049	<0.0010
PC-PERIMETER-M03-4L-DCL	1878	37	1	0	0.00049	<0.00049	0.00049	<0.00049	0.0015
PC-PERIMETER-M03-4L-DCL-DUP*	1878	37	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0014
PC-PERIMETER-M04-4L-DCL	1936	36	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0020
PC-PERIMETER-M05-4L-DCL	1872	37	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0010
PC-PERIMETER-M06-4L-DCL	1893	37	0	0	<0.00048	<0.00048	<0.00048	<0.00048	<0.0017
PC-PERIMETER-M07-4L-DCL	1899	36	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0028
PC-PERIMETER-M08-4L-DCL	1825	38	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0053
PC-PERIMETER-M09-4L-DCL*	1852	37	4	0	0.0020	<0.00049	0.0020	<0.00049	<0.0010
PC-PERIMETER-M10-4L-DCL*	1832	38	1	0	0.00049	<0.00049	0.00049	<0.00049	0.0024
PC-PERIMETER-M11-4L-DCL*	1875	37	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0019
PC-PERIMETER-M12-4L-DCL*	1797	39	0	0	<0.00048	<0.00048	<0.00048	<0.00048	<0.0011
PC-PERIMETER-M12-4L-DCL-DUP*	1852	37	3	0	0.0015	<0.00049	0.0015	<0.00049	0.0016
PC-PERIMETER-M13-4L-DCL*	1830	37	1	0	0.00050	<0.00050	0.00050	<0.00050	0.0038
PC-PERIMETER-M14-4L-DCL*	1879	37	6	0	0.0029	<0.00049	0.0029	<0.00049	<0.0010
PC-PERIMETER-M15-4L-DCL*	1886	37	5	0	0.0024	<0.00048	0.0024	<0.00048	<0.0010
PC-PERIMETER-M16-4L-DCL*	1962	35	6	0	0.0030	<0.00049	0.0030	<0.00049	<0.0001
PC-PERIMETER-M17-4L-DCL*	1946	36	5	0	0.0024	<0.00048	0.0024	<0.00048	0.0019
PC-PERIMETER-M18-4L-DCL	1898	36	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0018
PC-PERIMETER-DCL-BL	0	10	0	0	--	--	--	--	--
PC-PERIMETER-DCL-BL	0	10	0	0	--	--	--	--	--
BG-AIR-BG01-8L-DCL	3707	18	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.00094
BG-AIR-BG02-4L-DCL**	1902	36	0	0	<0.00047	<0.00047	<0.00047	<0.00047	0.0043
BG-AIR-BG03-8L-DCL	3683	18	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.00068
BG-AIR-BG04-8L-DCL	3645	18	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0023
BG-AIR-BG04-8L-DCL-DUP	3645	18	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0025
BG-AIR-BG05-8L-DCL	3650	18	0	0	<0.00049	<0.00049	<0.00049	<0.00049	0.0013
BG-AIR-BG06-8L-DCL	3672	18	0	0	<0.00048	<0.00048	<0.00048	<0.00048	0.0014

[1]Grid opening size = 0.0144 mm²; effective filter area = 385 mm².

[2]Less than values represent the analytical sensitivities; detection limits are 2.99 times higher, per ISO 10312.

* Sample was heavily loaded with encapsulated particles but analyzed by the direct method.

** Sample # BG-AIRBG02-8L-DCL was overloaded with a particle loading of >20%; BG-AIRBG02-4L-DCL was analyzed instead.

Table 13-7. PAVEMENT/ SURFACE SAMPLES

Sample Number	Area, cm^2	Grid Openings Analyzed	Structures Counted		Asbestos (TEM), s/cm^2			
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME[1]
AACM PC Building – Site Assessment Pavement/Walk Samples								
01-MV-BG[2]	100	22	10	0	9,810	<1000	9,810	NA
02-MV-BG	100	108	1	0	999	<1000	999	NA
03-MV-BG	100	108	1	0	999	<1000	999	NA
04-MV-BG	100	36	0	0	<1000	<1000	<1000	NA
07-MV-BG	100	36	54	0	54,000	<1000	54,000	NA
08-MV-BG	100	22	22	0	21,600	<1000	21,600	NA
09-MV-BG	100	11	9	0	8,830	<1000	8,830	NA
AACM PC Building – Pre-Demolition Pavement Samples								
PC-PAVPRE-01-2L	100	10	0	0	<730	<730	<730	NA
PC-PAVPRE-02-2L	100	55	0	0	<1000	<1000	<1000	NA
PC-PAVPRE-03-2L	100	10	0	0	<730	<730	<730	NA
PC-PAVPRE-04-BL	100	10	0	0	<730	<730	<730	NA
AACM PC Building – Post-Demolition Slab Samples								
PC-SLABPOST-01-2L	100	10	0	0	<730	<730	<730	NA
PC-SLABPOST-02-2L	100	10	0	0	<730	<730	<730	NA
PC-SLABPOST-03-2L	100	10	13	0	9,500	<730	9,500	<730
PC-SLABPOST-04-2L	100	10	39	0	29,000	<730	29,000	1,500
PC-SLABPOST-05-2L	100	5	100	0	1,100,000	<11,000	1,100,000	55,000
PC-SLABPOST-06-2L	100	55	29	0	29,000	<1,000	29,000	<1,000
PC-SLABPOST-2L-BL	100	10	0	0	<730	<730	<730	NA
AACM PC Building – Post-Demolition Pavement Samples								
PC-PAVEPOST-01-2L	100	10	0	0	<730	<730	<730	NA
PC-PAVEPOST-02-2L	100	10	0	0	<730	<730	<730	NA
PC-PAVEPOST-03-2L	100	10	0	0	<730	<730	<730	NA
PC-PAVEPOST-04-BL	100	10	0	0	<730	<730	<730	NA
AACM PC Building – Background Pavement Samples								
BG-PAVE-01-2L	100	10	0	0	<730	<730	<730	NA
BG-PAVE-02-2L	100	10	0	0	<730	<730	<730	NA
BG-PAVE-03-2L	100	10	0	0	<730	<730	<730	NA
BG-PAVE-04-2L	100	10	0	0	<730	<730	<730	NA
BG-PAVE-05-BL	100	10	0	0	<730	<730	<730	NA

Analytical sensitivity ranged from 730 to 1,000 s/cm^2.

[1]Only samples with detectable amounts of ACM by the ASTM 5755 were sent to ISO 10312 analyses (PCME).

[2]Samples 01-MV-BG through 09-MV-BG were analyzed by ISO 10312.

Table 13-8. SETTLED DUST SAMPLES

Sample Number[1]	Sample Duration (min)	Grid Openings Analyzed	Structures Counted		Asbestos (TEM), s/cm^2			
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME
AACM PC Building – Asbestos in Settled Dust During Pre-Wetting (Perimeter Stations)								
PC-DUST-M01W	813	10	0	0	<240	<240	<240	<240
PC-DUST-M02W	807	10	2	0	480	<240	480	<240
PC-DUST-M02W-DUP	806	10	0	0	<240	<240	<240	<240
PC-DUST-M03W	803	10	0	0	<240	<240	<240	<240
PC-DUST-M04W	800	10	0	0	<240	<240	<240	<240
PC-DUST-M05W	799	10	0	0	<240	<240	<240	<240
PC-DUST-M06W	797	10	0	0	<240	<240	<240	<240
PC-DUST-M07W	794	10	0	0	<240	<240	<240	<240
PC-DUST-M08W	787	10	0	0	<240	<240	<240	<240
PC-DUST-M09W	785	10	0	0	<240	<240	<240	<240
PC-DUST-M10W	781	10	0	0	<240	<240	<240	<240
PC-DUST-M10W-DUP	781	10	0	0	<240	<240	<240	<240
PC-DUST-M11W	779	10	2	0	480	<240	480	<240
PC-DUST-M12W	775	10	0	0	<240	<240	<240	<240
PC-DUST-M13W	772	10	0	0	<240	<240	<240	<240
PC-DUST-M14W	773	10	0	0	<240	<240	<240	<240
PC-DUST-M15W	772	10	0	0	<240	<240	<240	<240
PC-DUST-M16W	772	10	0	0	<240	<240	<240	<240
PC-DUST-M17W	772	10	0	0	<240	<240	<240	<240
PC-DUST-M18W	771	10	1	0	240	<240	240	<240
PC-DUST-W-BL	30 Sec.	10	0	0	<240	<240	<240	<240
PC-DUST-W-BL	30 Sec.	10	0	0	<240	<240	<240	<240
AACM PC Building – Asbestos in Settled Dust During Wetting (Background Stations)								
BG-DUST-BG01W	866	4	140	0	1,100,000	<7,500	1,100,000	7,500
BG-DUST-BG02W	865	10	19	0	4,600	<240	4,600	<240
BG-DUST-BG03W	865	10	0	0	<240	<240	<240	<240
BG-DUST-BG04W	865	10	0	0	<240	<240	<240	<240
BG-DUST-BG04W-DUP	864	10	0	0	<240	<240	<240	<240
BG-DUST-BG05W	864	10	0	0	<240	<240	<240	<240

Sample Number[1]	Sample Duration (min)	Grid Openings Analyzed	Structures Counted		Asbestos (TEM), s/cm^2			
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME
BG-DUST-BG06W	864	10	0	0	<240	<240	<240	<240
BG-DUST-BG-W-BL	30 Secs	10	0	0	<240	<240	<240	<240
AACM PC Building – Asbestos in Settled Dust During Demolition, Excavation and Cleaning (Perimeter Ring)								
PC-DUST-M01D	1685	10	0	0	<240	<240	<240	<240
PC-DUST-M02D	1687	10	0	0	<240	<240	<240	<240
PC-DUST-M02D-DUP	1688	10	0	0	<240	<240	<240	<240
PC-DUST-M03D	1687	10	7	0	1,700	<240	1,700	<240
PC-DUST-M04D	1689	10	25	0	6,000	<240	6,000	<240
PC-DUST-M05D	1688	10	7	0	1,700	<240	1,700	<240
PC-DUST-M06D	1687	10	10	0	2,400	<240	2,400	<240
PC-DUST-M07D	1685	10	38	0	9,200	<240	9,200	<240
PC-DUST-M08D	1683	10	62	0	15,000	<240	15,000	<240
PC-DUST-M09D	1688	10	49	0	12,000	<240	12,000	<240
PC-DUST-M10D	1692	10	38	0	9,200	<240	9,200	<240
PC-DUST-M10D-DUP	1695	13	46	0	11,000	<240	11,000	<240
PC-DUST-M11D	1695	17	33	0	7,800	<240	7,800	<240
PC-DUST-M12D	1697	25	44	0	11,000	<240	11,000	<240
PC-DUST-M13D	1700	49	52	0	13,000	<240	13,000	<240
PC-DUST-M14D	1703	49	44	0	11,000	<240	11,000	<240
PC-DUST-M15D	1703	50	67	0	16,000	<240	16,000	<240
PC-DUST-M16D	1705	81	57	0	14,000	<250	14,000	<240
PC-DUST-M17D	1698	46	104	0	45,000	<440	45,000	<240
PC-DUST-M18D	1693	10	2	0	480	<240	480	<240
PC-DUST-D-BL	30 Secs	10	0	0	<240	<240	<240	<240
PC-DUST-D-BL	30 Secs	10	0	0	<240	<240	<240	<240
AACM PC Building – Asbestos in Settled Dust During Demolition, Excavation and Cleaning (Background Stations)								
BG-DUST-BG01D	1698	10	0	0	<240	<240	<240	<240
BG-DUST-BG02D	1700	10	0	0	<240	<240	<240	<240
BG-DUST-BG03D	1708	10	0	0	<240	<240	<240	<240
BG-DUST-BG04D	1707	10	0	0	<240	<240	<240	<240
BG-DUST-BG04D-DUP	1707	10	0	0	<240	<240	<240	<240
BG-DUST-BG05D	1708	10	0	0	<240	<240	<240	<240

Sample Number[1]	Sample Duration (min)	Grid Openings Analyzed	Structures Counted		Asbestos (TEM), s/cm^2			
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME
BG-DUST-BG06D	1708	10	0	0	<240	<240	<240	<240
BG-DUST-D-BL	30 Secs	10	0	0	<240	<240	<240	<240
AACM PC Building – Asbestos in Settled Dust During Demolition (Balconies Adjacent to Site)								
PC-DUST-R01D	775	10	0	0	<240	<240	<240	<240
PC-DUST-R02D	775	10	10	0	2,400	<240	2,400	240
PC-DUST-R03D	775	10	12	0	2,900	<240	2,900	<240
PC-DUST-R04D	779	10	0	0	<240	<240	<240	<240
PC-DUST-R05D	779	10	16	0	3,900	<240	3,900	<240
PC-DUST-R06D	778	10	21	0	5,100	<240	5,100	<240
AACM PC Building – Asbestos in Settled Dust During Demolition (On top of Boca Raton Boulevard Wall)								
PC-DUST-B01D	634	10	0	0	<240	<240	<240	<240
PC-DUST-B02D	634	10	0	0	<240	<240	<240	<240
PC-DUST-B03D	628	10	0	0	<240	<240	<240	<240
AACM PC Building – Asbestos in Settled Dust During Demolition (Woodstock Apartments)								
PC-DUST-WS01D	701	10	0	0	<240	<240	<240	<240
PC-DUST-WS02D	701	10	0	0	<240	<240	<240	<240
PC-DUST-WS03D	700	10	0	0	<240	<240	<240	<240

TABLE 13-9. SOIL (PLM AND TEM) SAMPLES

Sample Number	Soil			
	PLM Point Count, % Asbestos	TEM (Asbestos)		
		Grid Openings Analyzed[1]	Structure Count	Structures/g
AACM PC Building – Asbestos in Soil (Background)				
PC-BG-SOIL-01	<0.1	10	0	<1.3E+6
PC-BG-SOIL-02	<0.1	10	12	1.36E+07
PC-BG-SOIL-03	<0.1	10	1	1.20E+06
PC-BG-SOIL-04	<0.1	10	0	<1.2E+6
AACM PC Building – Asbestos in Soil Pre Demolition				
PC-SOILPRE-01	<0.1	10	3	3.59E+06
PC-SOILPRE-02	<0.1	10	1	1.13E+06
PC-SOILPRE-03	<0.1	10	2	2.18E+06
PC-SOILPRE-04	<0.1	10	0	<1.2E+6
PC-SOILPRE-05	<0.1	10	1	1.14E+06
PC-SOILPRE-06	<0.1	10	0	<1.2E+6
AACM PC Building – Asbestos in Soil Post Demolition				
PC-SOILPOSTDEMO-01	<0.1	10	19	1.91E+07
PC-SOILPOSTDEMO-02	<0.1	10	4	4.31E+06
PC-SOILPOSTDEMO-03	<0.1	10	1	1.04E+06
PC-SOILPOSTDEMO-04	<0.1	10	0	<1.2E+6
PC-SOILPOSTDEMO-05	<0.1	10	1	9.31+05
PC-SOILPOSTDEMO-06	<0.1	10	3	6.27E+06
AACM PC Building – Asbestos in Soil Post Excavation				
PC-SOILPOSTEX-01	<0.1	10	0	<1.3E+6
PC-SOILPOSTEX-02	<0.1	10	0	<1.1E+6
PC-SOILPOSTEX-03	<0.1	10	0	<1.1E+6
PC-SOILPOSTEX-04	<0.1	10	0	<1.1E+6
PC-SOILPOSTEX-05	<0.1	10	0	<1.2E+6
PC-SOILPOSTEX-06	<0.1	10	3	3.68E+06

[1]Grid opening size = 0.0135 mm^2

PLM analytical sensitivity equals 0.1 percent.

TEM analytical sensitivity ranged from 1.1×10^6 to 1.3×10^6 s/g.

TABLE 13-10. WORKER PCM BREATHING ZONE SAMPLES

Sample ID	Air Volume, liters	Fibers/cm^3	Time Sampled, min	Time Sampled, hours	TWA, fibers/cm^3
During Pre-Wetting					
PC-LUISMORENO-2LW	150	<0.0130	74	1.23	0.0020
PC-MARCOSGOMEZ-2LW	141	0.037	69	1.15	0.00009
During Demolition/Debris Disposal					
PC-EDCASTELLANOS-2LD	1163	0.0030	574	9.57	0.00006
PC-MARCOSGOMEZ-2LD	1214	0.015	594	9.90	0.0003
PC-CARLOSGARDENA-2LD	1206	0.012	596	9.93	0.0002
PC-LEEDASNACHEZ-2LD	1197	0.0092	597	9.95	0.0002
PC-EDCASTELLANOS-2LD-DUP	1170	0.0090	573	9.55	0.0002
PC-KENCALLOWAY-2LD[1]	1224	0.010	622	10.37	0.0002
PC-LOUISMORENO-2LD	1141	0.0018	572	9.53	0.00004
PC-CARLOSGARDENA-2LD-DUP	1259	0.011	596	9.93	0.0002
PC-WORK-D-BL	0	---			
PC-WORK-D-BL	0	---			
During Excavation (Soil Removal)					
PC-LOUISMORENO-2LDEX	799	0.0081	408	6.80	0.0001
PC-LOUISMORENO-2LDEX-DUP	828	0.0088	408	6.80	0.0001
PC-CARLOSGARDENA-2LDEX	941	0.014	479	7.98	0.0002
PC-CARLOSGARDENA-2LDEX-DUP	979	0.025	484	8.07	0.0004
PC-MARCOSGOMEZ-2LDEX	931	0.016	472	7.87	0.0003
PC-LEEDASNACHEZ-2LDEX	883	0.016	449	7.48	0.0002
PC-KENCALLOWAY-2LDEX[1]	906	0.018	462	7.70	0.0003
PC-WORK-DEX-BL	0	---			
PC-WORK-DEX-BL	0	---			
During Cleaning/Equipment Decon					
PC-CARLOSGARDENA-2LDCL[1]	937	0.0072	454	7.57	0.0001
PC-CARLOSGARDENA-2LDCL-DUP[1]	921	<0.0021	453	7.55	0.00003
PC-MARCOSGOMEZ-2LDCL[1]	922	0.011	452	7.53	0.0002
PC-MARCOSGOMEZ-2LDCL-DUP[1]	916	0.021	451	7.52	0.0003
PC-LEEDASNACHEZ-2LDCL[1]	904	0.020	449	7.48	0.0003
PC-KENCALLOWAY-2LDCL[1]	713	0.013	352	5.87	0.0002
PC-WORK-DCL-BL	0	---			
PC-WORK-DCL-BL	0	---			

[1]**S**amples were considered for indirect preparation using the indirect transfer procedure outlined in ISO 13974:1999 (E) due to overloaded particulate but were analyzed by the direct method.

TABLE 13-11. WORKER TEM BREATHING ZONE SAMPLES

Sample ID	Air Volume, Liters	Total Asbestos Structures Counted	Total Asbestos, s/cm^3
PC-LUISMORENO-2LW	150	0	<0.0049
PC-MARCOSGOMEZ-2LW	141	0	<0.0049
During Demolition/Debris Disposal			
PC-EDCASTELLANOS-2LD	1163	0	<0.0029
PC-MARCOSGOMEZ-2LD	1214	0	<0.0028
PC-CARLOSGARDENA-2LD	1206	0	<0.0028
PC-LEEDASNACHEZ-2LD	1197	0	<0.0028
PC-EDCASTELLANOS-2LD-DUP	1170	0	<0.0029
PC-KENCALLOWAY-2LD[1]	1224	0	<0.0028
PC-LOUISMORENO-2LD	1141	0	<0.0030
PC-CARLOSGARDENA-2LD-DUP	1259	0	<0.0027
PC-WORK-D-BL	0	---	---
PC-WORK-D-BL	0	---	---
During Excavation (Soil Removal)			
PC-LOUISMORENO-2LDEX	799	**1**	0.0042
PC-LOUISMORENO-2LDEX-DUP	828	0	<0.0041
PC-CARLOSGARDENA-2LDEX	941	0	<0.0036
PC-CARLOSGARDENA-2LDEX-DUP	979	0	<0.0035
PC-MARCOSGOMEZ-2LDEX	931	0	<0.0036
PC-LEEDASNACHEZ-2LDEX	883	0	<0.0038
PC-KENCALLOWAY-2LDEX[1]	906	0	<0.0037
PC-WORK-DEX-BL	0	---	---
PC-WORK-DEX-BL	0	---	---
During Cleaning/ Equipment Decon			
PC-CARLOSGARDENA-2LDCL[1]	937	0	<0.0036
PC-CARLOSGARDENA-2LDCL-DUP[1]	921	0	<0.0037
PC-MARCOSGOMEZ-2LDCL[1]	922	0	<0.0037
PC-MARCOSGOMEZ-2LDCL-DUP[1]	916	0	<0.0037
PC-LEEDASNACHEZ-2LDCL[1]	904	0	<0.0037
PC-KENCALLOWAY-2LDCL[1]	713	0	<0.0047
PC-WORK-DCL-BL	0	---	---
PC-WORK-DCL-BL	0	---	---

[1]**S**amples were considered for indirect preparation using the indirect transfer procedure outlined in ISO 13974:1999 (E) due to overloaded particulate but were analyzed by the direct method.

TABLE 13-12. WATER SAMPLES

Sample Number	Grid Openings Analyzed	Asbestos Concentration >10 μ, MFL	Total Asbestos Concentration, MFL
Hydrant Source Water			
PC-HW-01	10	<0.040	<0.040
PC-HW-02	10	<0.040	<0.040
PC-HW-02-DUP	10	<0.040	<0.040
PC-HW-BL	10	<0.040	<0.040
Amended Water			
PC-AW-01	108	<0.040	<0.040
PC-AW-02	55	<0.040	<0.040
PC-AW-03	55	<0.040	<0.040
PC-AW-03-DUP	10	0.3	3.8
PC-AW-BL	10	<0.040	<0.040
Accumulated Surface Water			
PC-AWSURF-01	108	10.0	69
PC-AWSURF-02	55	2.0	22
PC-AWSURF-03	55	16	94
PC-AWSURF-03-DUP	18	120	1300
PC-AWSURF-BL	10	<0.040	<0.040