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Evaluation of the Alternative Asbestos Control Method at Site Two (AACM2) for Demolition of Asbestos-Containing Buildings

By

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Foreword

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Sally Gutierrez, Director
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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 effort (AACM2) is the second of the AACM research efforts, each targeting specific asbestos and building/site configurations. AACM2 evaluated the use of the AACM process on a transite-covered building that was in danger of imminent collapse at the Fort Chaffee Redevelopment Authority near Fort Smith, AR. Separate reports have been issued for AACM1 and AACM3.

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 transite building (AACM2) at Fort Chaffee Redevelopment Authority:

Primary Objective:

- The airborne asbestos concentrations measured by transmission electron microscopy (TEM) during the AACM2 demolition processes were orders of magnitude below any EPA existing health or performance criterion. Almost all of the airborne asbestos (TEM) concentrations were near or below the limit of detection, which was 0.0015 s/cm^3 (or 2.99 times the analytical sensitivity of 0.0005 s/cm^3). Only five samples exceeded the limit of detection, with the highest total asbestos concentration being 0.0052 s/cm^3.

- The statistical analyses were restricted by differences in results from different analytical laboratories and by the fact that some laboratory samples were overloaded and required indirect analysis, which are not directly comparable with direct analysis results. First, the statistical analyses concluded that there were differences in results from the different laboratories. Using one lab's results, the inferential statistics indicated *since the background mean detection limit was below the lower limit of the confidence interval (0.00057 s/cm^3), one would conclude it was significantly different than the mean perimeter concentration of 0.0014 s/cm^3*. Using the second lab's results, however, the statistical conclusions were that *one would conclude there was no difference in the probability of observing a censored (non-detect) value in the perimeter and background data sets*. Overall, the statistical analyses were inconclusive in determining whether there was a difference between the perimeter and background airborne asbestos concentrations.

Secondary Objectives

AIR

- No visible emissions were observed during the AACM2 demolition.

- Virtually all the perimeter, top of wall, and background air samples were non-detect for fibers as measured by Phase Contrast Microscopy (PCM). There was one single fiber detected in one sample (0.001 f/cm^3). This is likely because there was little fibrous material in the transite building to begin with and because the amended water was effective at suppressing releases.

DUST

- Many of the perimeter samples and some of the background samples contained asbestos in the dust. The maximum dust loading was 3,980 s/cm^2 in a perimeter sample and 958 s/cm^2 in a background sample. Although *the statistical analyses indicated one would fail to reject the null hypothesis of no difference in the asbestos concentrations in the settled dust (TEM s/cm^2) for perimeter and background*, the empirical data appear to indicate a difference in the asbestos concentrations. Also*, due to the high level of censoring(non-detects), an inferential test for AACM and BKGD mean differences could not be conducted, the Kaplan-Meier test indicated that the mean concentration of asbestos in the AACM2 perimeter settled dust was greater than background.*

WORKERS

- Five of the seven worker breathing zone samples were non-detect for total asbestos at the 0.001 s/cm^3 analytical sensitivity level. None of the worker samples showed detectable PCME asbestos structures during the demolitions. The two worker samples that showed detectable asbestos had breathing zone asbestos concentrations of 0.006 and 0.002 s/cm^3 respectively.

- Only one of the six workers had PCM fibers observed on their breathing zone filters, and that concentration was 0.003 f/cm^3. Time-weighted averages, based upon the PCM fiber counts above, were therefore well below the OSHA Personal Exposure Limit (PEL) of 0.1 f/cm^3.

PAVEMENT

- The site assessment survey data showed very high pavement dust asbestos loadings (2,700,000 s/cm^2 max), highlighting the problem of erosion of weathered transite and subsequent contamination of adjacent surfaces. The AACM2 effectively reduced the pavement dust levels as seven of eight post-demolition pavement samples were non-detect for asbestos. *The statistical analysis indicated that one would conclude there was a difference in the probability of observing a censored (non-detect) value in the pre- and* *post-demolition data sets; i.e., one is more likely to observe a censored value in the post-demolition data.*

WATER

- As has been seen in each of the AACM demolitions, the amended water captured significant amounts of asbestos. The mean asbestos concentration in the captured AACM water was about 40 billion asbestos structures (of all sizes) per liter. This water was all captured, filtered, and disposed to the sanitary sewer.

TIME

- Even with delays caused by the research nature of the project and the extreme heat hampering worker effectiveness, it required two days to demolish the transite building by the AACM protocol; it is estimated that three days would have been required for the NESHAP protocol if abatement had been done.

COST

- Overall, the use of AACM2 at the transite building and disposal of the waste at the Fort Smith Landfill was about equal to what the demolition cost would have been by the NESHAP. The total cost for the AACM2 process was $23,873 compared to $24,615 for the NESHAP (with abatement). If the building would have been demolished by the NESHAP Imminent Danger provision, it would have cost an estimated $15,380.

CONTAINMENT

- The barrier wall constructed immediately adjacent to the back side of the transite building to simulate closely adjacent buildings was very effective in minimizing asbestos migration. All three of the air samples on top of the barrier wall were non-detect for asbestos. Only one of the three dust samples had asbestos detected and that loading was minimal (2,740 s/cm^2).

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

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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).

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 this 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. A third study has also been conducted (AACM3) to evaluate 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 AACM2 will be used in conjunction with data obtained during AACM1 and AACM3 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 transite. 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
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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). 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

2.5.2 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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.

2.10 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.

2.11 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.

2.12 Personal Protective Equipment (PPE)

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

2.13 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.

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.

2.14 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.

2.15 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 transite. All of the data collected were evaluated and considered, as appropriate, to make this comparison.

The quality assurance project plan (QAPP), *Evaluation of an Alternative Asbestos Control Method for Building Demolition, March 2006* was developed by ORD in combination with the select EPA QAPP Technical Development Team 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 this study (AACM2) was revised from the first QAPP to be tailored to the new site and was reviewed by many of the QAPP Technical Development Team members. The following project objectives are specified for AACM2:

3.1 Primary Objectives

1. To determine if the airborne asbestos (TEM) concentrations from the AACM2 demolition are statistically equal to or less than the background asbestos (TEM) concentrations.

3.2 Secondary Objectives

The following secondary objectives provided additional information to further characterize the interrelationships among several multimedia parameters to enhance the understanding of the process and to further the science:

3.2.1 AIR

1. To document visible emissions during the AACM2 demolition.

2. To determine total fibers in air (phase contrast microscopy (PCM)) during the AACM2 demolition and compare to background concentrations.

3.2.2 DUST

3. To determine the settled dust asbestos concentrations during the demolition of the transite building by the AACM2 process and compare those to background concentrations.

3.2.3 WORKER

4. To determine worker breathing zone fiber concentrations (PCM) during the AACM2.

5. To determine worker breathing zone asbestos concentrations (TEM) during the AACM2.

3.2.4 PAVEMENT

6. To determine the asbestos concentration in post-cleanup pavement (TEM) from the AACM2 demolition and compare those to pre-demolition pavement concentrations and to background asbestos concentrations.

3.2.5 WATER

7. To measure the asbestos concentrations in the source water, the amended water applied during demolition, and the surface water captured from the AACM2 demolition.

3.2.6 TIME

8. To document the time required for all activities related to the demolition by the AACM2.

3.2.7 COST

9. To document the cost required for all activities related to the demolition by the AACM2 and to compare those with estimated costs for demolition of the building by the NESHAP process.

3.2.8 CONTAINMENT

10. To document the effectiveness of constructing a barrier in close proximity to the building in preventing migration of asbestos from the demolition

SECTION 4 SITE INFORMATION

4.1 Site Selection

The site selected was a World War II era two-story building covered with transite siding. The building (#235) as shown in Figure 4-1and Figure 4-2 was located at Fort Chaffee Redevelopment Authority near Fort Smith, Arkansas, and was surrounded mostly by paved surfaces. The structure had previously been used as a maintenance building. The structure was determined by the City of Fort Smith building officials to be “structurally unsound and in danger of imminent collapse” as shown in Figure 4-3 and Figure 4-4. About one fourth of the roof had collapsed and several structural beams had failed. Because the building was deemed “structurally unsound and in imminent danger of collapse”, a No Action Assurance (NAA) was not required to allow the Agency to conduct this demolition.

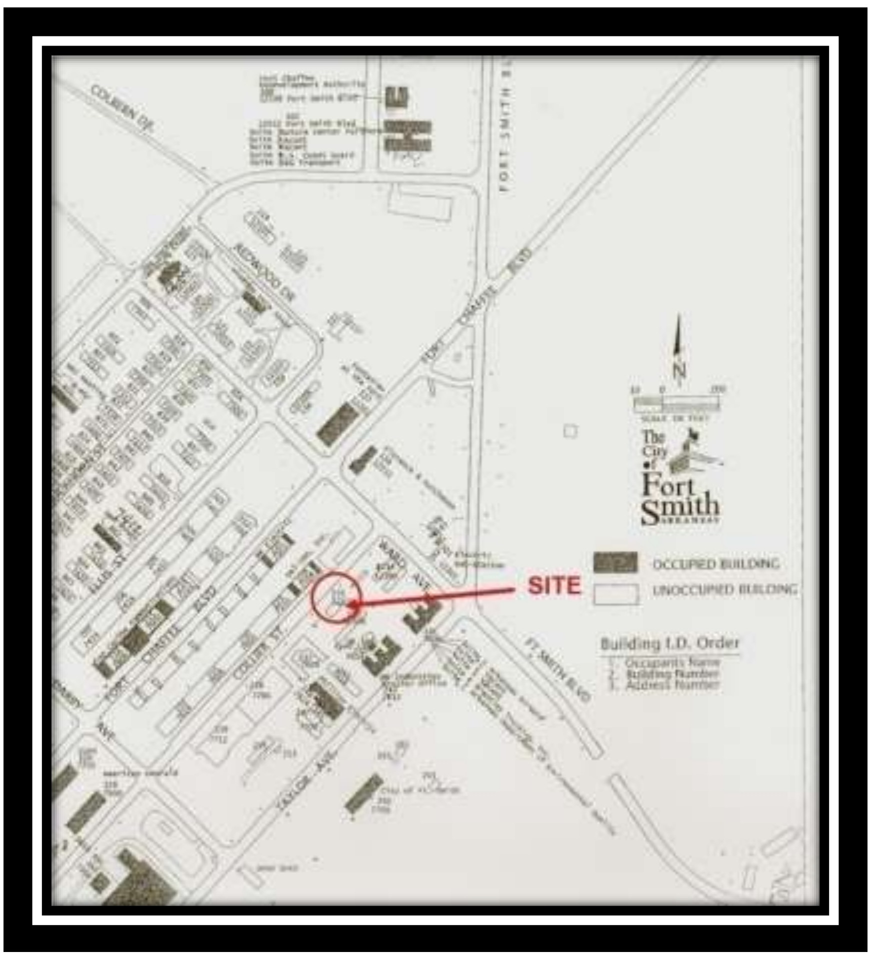

Figure 4-1. Site location for the AACM2 demolition.

Figure 4-2. Transite building before modifications.

Figure 4-3. Interior view of the damaged roof in the transite building.

Figure 4-4. Interior view of the damaged roof in the transite building.

4.2 Building/Site Assessment and Description

Prior to the site selection, site assessment sampling and analyses were conducted for asbestos in the air and hydrant water and on the pavement surface was conducted per "*QAPP – AACM Evaluation (Phase 2) – Site Assessment Sampling and Analysis*" (Ferguson 2007), using the same sampling and analytical techniques described in SECTION 5 and SECTION 6, except that the laboratory mistakenly used AHERA counting rules rather than modified ISO counting rules on the pavement samples, which likely would produce a lower total asbestos count. Four air samples plus one blank, two hydrant water samples plus one blank, and four pavement dust samples plus one blank were collected at the site on May 30-31, 2007, approximately two months prior to the study. The air samples were spaced at four quadrants 25 feet from the transite building, two of the pavement samples were taken near the transite building and two were taken 25 feet away, and the water samples were taken at the hydrant near the transite building, after allowing the water to run until it was relatively clear (about 20 minutes). All asbestos counts include both long and short fibers. Winds were light (mean 2.5 mph, max 7.5 mph), generally from the east-northeast. The results are presented in Table 4-1.

Table 4-1. SITE ASSESSMENT SAMPLE RESULTS

	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)
Pavement Surface Near the Building	2.5 x10^6 s/cm^2	2.7x10^6 s/cm^2	2.2x10^6 s/cm^2
Pavement Surface 25-ft Away	1.5x10^4 s/cm^2	3.0 x10^4 s/cm^2	500 s/cm^2

ms/L =million asbestos structures per liter.

The asbestos loadings in the site assessment pavement dust samples were surprisingly high, particularly adjacent to the building, indicating that the transite panels on the building had been degrading over the years and were contributing significant asbestos to the immediate paved area surrounding the building. Importantly, a typical NESHAP demolition of this building would not have significantly reduced the pavement asbestos loadings, since water is only added for suppression of dust and no pavement cleaning would have been typically undertaken. ***The pavement dust loadings proved to be a significant observation and will be discussed in the Results section of the report.***

4.2.1 Site/Building Preparation

The site selected was building #235 at the Fort Chaffee Redevelopment Authority site in Fort Smith, Arkansas (Figure 4-5 and Figure 4-6). The building was determined by the City of Fort Smith Building Department to be structurally unsound and in imminent danger of collapse. The City issued a demolition order June 11, 2007 to the Fort Chaffee Redevelopment Authority to demolish the building by December 31, 2007. The building was approximately 32’ x 48’ x 14’ for a footprint of 1,536 ft^2 and was partially covered by about 978 square feet of residential grade transite siding and which contained 30-percent chrysotile asbestos.

The interior of the building contained stockpiled material as shown in Figure 4-6 consisting largely of wooden desk components and boxes of one-in wide Velcro. Because of the imminent danger of building collapse, these materials were not removed prior to demolition. The Velcro was particularly problematic during the demolition as discussed later.

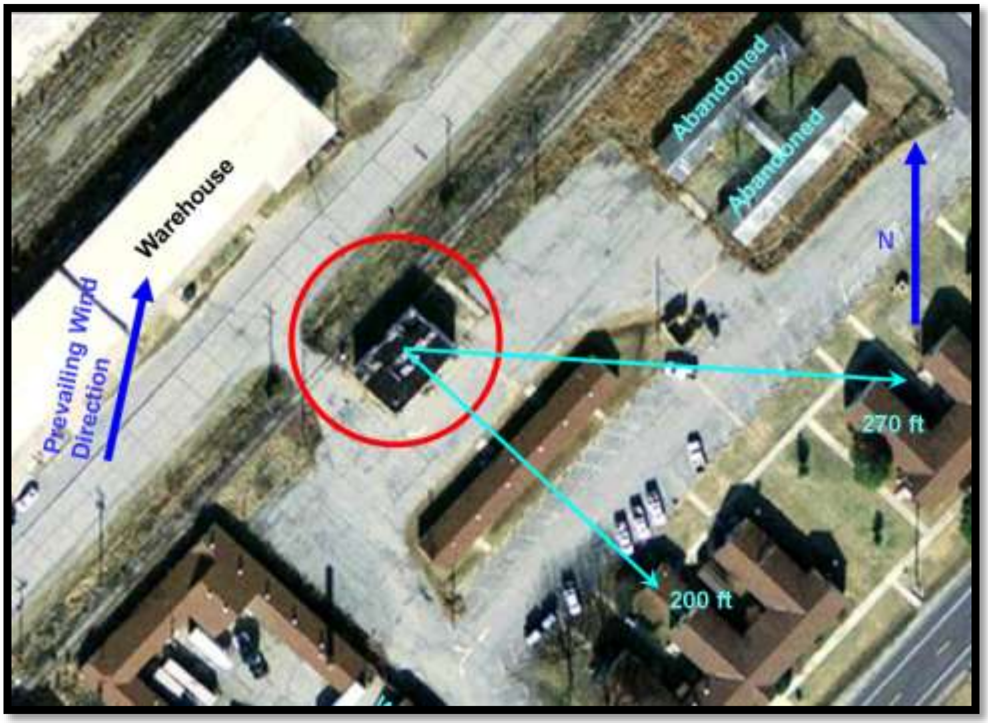

Figure 4-5. Aerial view of the site.


Figure 4-6. Interior view of transite building showing stockpiled materials.

4.2.2 Building Modifications

The building had areas with partial wood siding and windows that had been partially boarded closed. The amount of transite on the structure qualified the building as a NESHAP structure. To enhance the transite quantity to assure a worse-case scenario, the project included the addition of commercial-grade transite panels on the exterior windows and doors. The outside plywood walls and the areas on the existing structure that were currently not covered with transite were sided with weathered transite obtained from shower buildings at the Fort Hood Army Base near Killeen, Texas and shipped to Fort Chaffee. Approximately 1800 sq ft of transite from Fort Hood was added to the building, with approximately 1550 sq ft on the exterior plus 250 sq ft of excess transite placed inside the building (Figure 4-7 through Figure 4-9). The additional transite from Fort Hood consisted of commercial grade four-ft by four-ft panels which also contained 30-percent chrysotile asbestos. The original transite was off-white in color with the Fort Hood transite being green, light brown and gray. The building with the added transite is shown in Figure 4-10 through Figure 4-12. In total, the building was covered on the exterior with about 2530 sq ft of transite with an additional 250 sq ft on the inside of the structure. Pictures of the process are shown in Figure 4-7 through Figure 4-12.

Figure 4-7. Boarding the openings to prepare for applying additional transite.

Figure 4-8. Boarding the openings to prepare for applying additional transite.

Figure 4-9. The building before the additional transite.


Figure 4-10. End view of the building after the extra transite addition.


Figure 4-11. Close-up of the added transite from Fort Hood.

Figure 4-12. Front view of the building after the extra transsite addition.

4.3 Barrier Wall Simulation

To address concerns of the peer reviewers for AACM1 that the AACM was not practical for use in close-proximity situations (such as row houses), a close-proximity barrier wall was added to this study to simulate demolition situations where the adjacent buildings are virtually beside the structure to be demolished. The barrier wall was constructed on the side of the building adjacent to the railroad tracks (the rear of the building) and was comprised of scaffolding that extended slightly beyond the full length of the transite building (to simulate row houses) and extended vertically about ten feet above the height of the existing building to prevent splashing. The barrier wall was placed about six feet from the wall of the transite building to further simulate the close-proximity of row housing-type conditions. The barrier wall was covered with plastic sheeting (Duraskrim). Pictures of the process are shown in Figure 4-13 through Figure 4-17.

Since the northwest and southwest faces of the building had gravel rather than pavement, these gravel surfaces were covered with plastic (Duraskrim) during the demolition for surface water collection and to prevent water runoff and debris from penetrating the gravel.

Figure 4-13. Rear view of transite building before the barrier construction.

Figure 4-14. Scaffolding for the barrier wall.

Figure 4-15. The barrier wall in place at the rear of the building.

Figure 4-16. The barrier wall in place at the rear of the building.

Figure 4-17. The Duraskrim fabric used for the barrier and gravel cover.

4.4 Public Awareness

A thorough public awareness program was utilized for the research effort. Two separate meetings were held at the site; the first for any affected neighbors and the second for the press, local public officials, and Congressional staffers as shown in Figure 4-18 through Figure 4-20. The meetings were coordinated by the Fort Chaffee Redevelopment Authority staff with the assistance of EPA public affairs staff from Region 6 and ORD.

Figure 4-18. Public awareness meeting with press, local officials, and Congressional staffers.

Figure 4-19. Public awareness meeting with press, local officials, and Congressional staffers.

Figure 4-20. Public awareness meeting with press, local officials, and Congressional staffers.

4.4.1 Building Inspections

4.4.1.1 Asbestos Inspection of Building

A comprehensive pre-demolition inspection was conducted in accordance with the Asbestos Hazard Emergency Response Act (AHERA) (40 CFR 763) to identify the type, quantity, location, and condition of Asbestos-Containing Materials (instead of only RACM) in the buildings (61.145 (a)). Under the EPA-NESHAP 40 CFR 61.145 (a), not only RACM must be identified prior to demolition or renovation but also Category I and Category II Non-friable Asbestos-Containing Materials. The results of this inspection follow (Waldo 2007):

The following materials, found in Building 235, were suspected of being asbestos-containing, but sampling and analytical testing by Polarized Light Microscopy (PLM) showed asbestos concentrations of less than or equal to one percent (1%). These materials are:

Table 4-2. ASBESTOS INSPECTION OF BUILDING 235

Material	Material Location
Felt under Original ACM Gray Cementitious Siding	Exterior of Building
Asphalt Siding	Exterior Fascia
Drywall (Unfinished)	Bathroom
Window Glaze	Exterior Windows
Built-Up Roofing	Roof
Felt Paper Flooring	Landing

As a result of the inspection conducted by EEG, the following materials were classified as asbestos-containing. EEG has made recommendations regarding each positive material in accordance with the AHERA guidelines…. *EEG recommends that the ACM be removed in accordance with local, state and federal regulations. Current Arkansas Department of Environmental Quality (ADEQ) regulations require all ACM in* ***significantly damaged*** *condition be removed prior to demolition activities.*

Table 4-3. ASBESTOS QUANTITIES IN BUILDING 235

Sample Group	**HA[1]**	**Material Description**	**Sample Location**	**Asbestos Content, Chrysotile**	**Quantity**	**Condition**
LBG-1A	1A	Original Gray Cementitious Siding with Non-ACM Felt	Exterior of Building	30%	978 ft^2	Significantly Damaged
LBG-1B	1B	Original Gray Cementitious Siding with Non-ACM Felt	Exterior of Building	30%	Included with LBG-1A	Significantly Damaged
LBG-1C	1C	Original Gray Cementitious Siding with Non-ACM Felt	Exterior of Building	30%	Included with LBG-1A	Significantly Damaged
LBG-2A	2A	Added Gray Cementitious Siding	Over Exterior Windows & Doors	30%	1,550 ft^2	Significantly Damaged

Sample Group	HA[1]	Material Description	Sample Location	Asbestos Content, Chrysotile	Quantity	Condition
LBG-2B	2B	Added Gray Cementitious Siding	Over Exterior Windows & Doors	30%	Included with LBG-2A	Significantly Damaged
LBG-2C	2C	Added Gray Cementitious Siding	Over Exterior Windows & Doors	30%	Included with LBG-2A	Significantly Damaged

[1]HA = Homogeneous Area
All were classed as non-friable.

In addition, the excess transite from Fort Hood was placed on the floor inside the garage door as illustrated in Figure 4-21.

4.4.1.2 Lead Paint Inspection of Buildings

Because the building was once used as a welding shop, it was prudent to measure demolition workers for lead. Also, representative composite bulk samples of the lead-containing building materials were analyzed to determine the leachable lead content (EPA SW-846 Method 1311, *Toxicity Characteristic Leaching Procedure*) to determine the composite suitability of the waste debris for disposal in the landfill. The results, which are presented in Table 13-10 of the Appendix, were below the reportable limit.

Figure 4-21. Excess transite from Fort Hood, placed in building.

4.4.2 Demolition of Building and Site Management

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

The amended water was applied to the AACM Building with two variable rate 15-gpm nozzles. A water meter was installed at the hydrant to measure the volume of water applied to the building. The surfactant used to create the amended water was applied using an in-line educator in each hose line. The surfactant used was Kidde NF-3000 produced by National Foam. The surfactant was diluted 50 percent with the hydrant water and mixed at one percent by volume (0.5-percent surfactant) through the eductor to create the amended water mixture that was applied to the building. The conductivity of the water was measured at the beginning of the demolition to ensure proper mixing. The conductivity was also checked about every two hours during the demolition. The concentration of the wetting agent is not nearly as significant as the presence of the wetting agent, i.e., it is imperative to assure that wetting agent is being applied. The presence of the wetting agent can be easily determined visually by the presence of foam as the spray impacts the structure.

Two buildings directly adjacent to the demolition site and two areas adjacent to the transite building were covered with plastic to ensure that any possible airborne contamination did not settle on those areas as illustrated in Figure 4-22. The first adjacent area was the warehouse building directly south east of building 235. The other area was the gravel and railroad tracks on the northwest side of the building. Plastic covered an area approximately 30 ft by 75 ft beginning four feet from building 235 and continuing along the length of the railroad tracks for about 75 ft.

Figure 4-22. Adjacent buildings were covered.

4.4.3 Monitoring

Air, dust, worker, water, and pavement samples were collected and analyzed to evaluate the impact of the AACM at this site. Specific requirements for monitoring and analysis are described in SECTION 5 and SECTION 6.

4.4.4 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-minute average) or gusts above 20 mph are 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-minutes minimum allowable within the confines of the test, or would be delayed until satisfactory conditions exist. Wind conditions at the selected site were continuously monitored by the onsite weather stations. ***No excessive wind situations occurred during the study.***

4.4.5 Costs

All costs associated with the demolition process, including cost of the demolition work scope, the health and safety plan and implementation, the costs of any abatement involved, the demolition itself, and the hauling/disposal aspects, were independently documented and tallied for the AACM. Costs for a hypothetical NESHAP demolition were derived from independent cost estimates of a hypothetical NESHAP demolition of that size building in that location.

SECTION 5 STUDY DESIGN AND IMPLEMENTATION

5.1 Sampling Strategy

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

Table 5-1. SUMMARY OF FIELD SAMPLES (EXCLUDING QUALITY CONTROL SAMPLES) COLLECTED FOR ASBESTOS ANALYSIS BY TEM

Description of Sample		**Transite Building**			
		Air[a]	**Pavement**	**Water**	**Settled Dust**
Pre-demolition site selection/assessment		4	4	2	-
Site the day before demolition		-	8	-	-
Background during demolition		6[b]	4	-	6
Ring during demolition		18[b]	-	-	18
Top of Wall		3[b]	-	-	3
Site the day after demolition		-	8	-	-
Worker	Excavator operator (1)	1	-	-	-
	Hose operators (2)	2	-	-	-
	Laborers (4)	4	-	-	-
Water	Source hydrant	-	-	2	-
	Amended	-	-	2	-
	Pooled surface	-	-	3	-
Total samples		38	24	9	27

[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.

In addition, lead samples were collected on each worker (seven total) for OSHA compliance.

5.1.1 Meteorological Monitoring

Meteorological conditions were determined and continuously monitored during sampling using a MetOne Automet Meteorological Monitoring System (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.

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-minute 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-minutes 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. ***During the study, none of the weather restriction situations were encountered.***

5.1.3 Demolition Site Sampling

5.1.3.1 Background Air Monitoring

Air and settled dust background monitoring was conducted during the demolition of the transite building to collect data necessary for potential comparison of air concentrations of asbestos and total fibers during demolition. The background sampler flow rate was eight liter/min for a target air volume for an eight-hour sample near 4000 liters.

The background air monitoring network for the background data consisted of six fixed-station samplers located about 1000 ft from the building, near the golf course (Figure 5-1). The background monitoring was conducted simultaneously with the demolition.

Figure 5-1. Background sampler array near the golf course.

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 10-15 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 or as close as possible to the demolition or debris loading areas. *Note:* On the left 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. Three additional samplers were placed at the top of the barrier wall at the rear of 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 back left corner of the building and then were numbered in a clockwise fashion around the structure. The roll-offs were loaded along the left of the building (samplers 16 through 18 in each grouping). Accumulated water was pumped from a sump constructed in the pavement next to sampler 15, which was the low point for drainage from the paved area.

Three additional asbestos/total fibers samplers and three additional dust samplers were placed at the top of the barrier wall at the rear of the building.

In accordance with the recommendations of the peer review of AACM1, particulate sampling was not done.

The perimeter air sampling network is shown for the transite building in Figure 5-2.

All primary air samples were collected at an airflow rate of eight liter/min for an anticipated eight-hr sampling time to achieve a target air volume near 4000 liters. Additionally, lower volume samples were collected at a flow rate of four liter/min for an anticipated eight-hr sampling time to achieve an air volume near 2000 liters, to serve as backup samples if the primary ones were overloaded. Some of the primary samples were overloaded; therefore these low flow samples were analyzed.

All air samplers were activated shortly before demolition activities began, and were continued until demolition activities ceased.

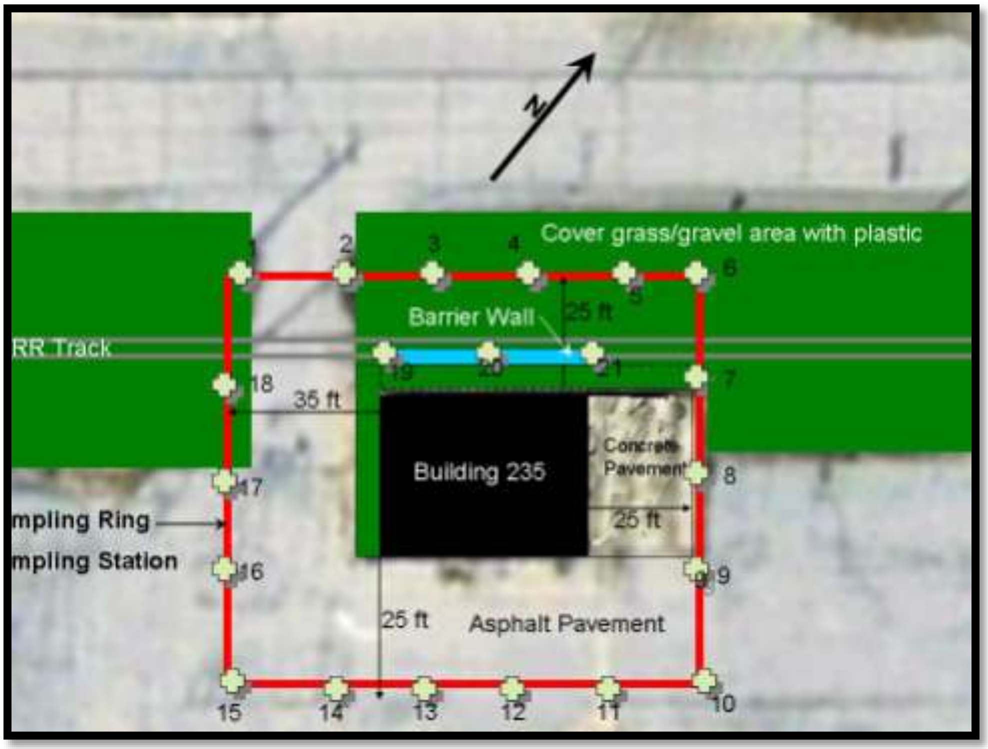

Figure 5-2. Location of samplers around the Transite building.

The adjacent buildings were covered in plastic for added security as shown in Figure 5-3.

Figure 5-3. Site preparation including covering adjacent buildings.

5.1.3.3 Work Area Sampling

5.1.3.3.1 Personal Breathing Zone Sampling During Demolition

Personal breathing zone samples were collected and analyzed for asbestos, total fibers, and for lead 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. For example, the samplers for the track hoe operator operated from the time the individual came on site until they left the site for the day.

5.1.4 Water for Wetting Structure and Demolition Debris

5.1.4.1 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 of the transite building. A source water sample was collected at both the commencement and completion of the demolition activities.

5.1.4.2 Amended Water

Samples of the amended water used in the AACM demolition were collected and analyzed for asbestos.

5.1.4.3 Surface Water from Demolition

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

5.1.5 Pavement Sampling

Pre-demolition pavement samples were collected prior to demolition of the transite 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 where the parking lots were seemingly unaffected by nearby structures with transite siding.

5.2 Site Preparation

5.2.1 Surface Water Control

For this study, containment berms were constructed surrounding the transite building. The natural drainage of the paved surfaces was from the rear of the building toward the front of the building and from then from the right front toward the left front. Most all the water therefore drained into the left front corner of the containment barrier, next to sample station 15. A small sump was constructed in the pavement at this spot and served as a pump-out point for the accumulated water. The location of the berms coincided with the location of the ring of samplers: i.e., about 25 ft from the buildings on three sides and 35 ft from the buildings on the left side (to permit containment area entrance and egress for the roll-off units). The haul trucks backed over absorbent bags laid across the driveway and dropped off the empty roll-offs and later retrieved them after they were filled and the burrito wrap was complete (Section 5.3.1.3). In this manner, neither the truck nor driver needed to enter the containment area.

Water within the containment berm was captured, stored, and later filtered through a 50-µm pre-filter and then a five-µm final filter, and then discharged to the sanitary sewer. Figure 5-4 through Figure 5-10 illustrate the surface water control system.

Figure 5-4. Preparing kerf in asphalt to construct barrier.

Figure 5-5. Inserting barrier into kerf in pavement.

Figure 5-6. Sealing barrier into kerf in pavement.

Figure 5-7. Finished barrier to prevent water runoff from site.

Figure 5-8. Sealed sewer access.

Figure 5-9. Pooled surface water collection sump.

Figure 5-10. Water holding tank and filtration system.

5.2.2 Sampling Network

The sampling stations were located on two-inch schedule 40 polyvinyl chloride (PVC) poles attached to an onsite-fabricated pump stand 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 but was not required to be used to feed the pumps during the study. All pumps were placed on a wooden table affixed to the standpipe. Figure 5-11 through Figure 5-15 show the sampling stations.

Figure 5-11. Preparation of sampling station supports.

Figure 5-12. Typical sampling station.


Figure 5-13. Part of the sampling array.

Figure 5-14. Sampling stations at the top of the barrier wall.

Figure 5-15. Typical samplers (high and low flow plus duplicate).

Collection of surface samples by the microvac technique is shown in Figure 5-16. The spot was marked on the pavement so that before and after samples could be taken near the same location.

Figure 5-16. Surface sampling on pavement.

The preparation and calibration of a worker breathing zone sampler is shown in Figure 5-17 and one of the meteorological stations for the study is shown in Figure 5-18.

Figure 5-17. Calibrating worker breathing zone sampler.

Figure 5-18. Primary meteorological sampling station.

Sampling during the demolition and recording water flow usage are shown in Figure 5-19 and Figure 5-20 respectively.

Figure 5-19. Performing periodic flow measurements on sampler arrays.

Figure 5-20. Documenting water usage.

5.3 Demolition and disposal of the transite building

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

- Demolition was accomplished by a track hoe
- Demolition debris disposal was into double-lined roll-off boxes and then to the Fort Smith landfill.
- Both the track hoe and the rubber-tired end loader were used to load debris.

5.3.1 AACM demolition and disposal

Prior to demolition of the transite building, no asbestos-containing materials were removed. As previously discussed, additional transite materials were added to the building to create a worst-case situation. Excess Fort Hood transite that was not able to be placed on the outside surface of the building was placed inside the building in the plastic bags that it came in. Nothing was removed from the interior of the building. There were old wooden desk components and many boxes of one-inch wide Velcro stored in the structure. As previously mentioned, the Velcro was very problematic during the demolition.

5.3.1.1 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. 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 appendix. 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 per gallon. Other wetting agents may be equally effective and may cost less.

The NF-3000 wetting agent was added to achieve target application strength of one-half percent concentration. In AACM1, a one-percent concentration was used. According to the manufacturer, the surfactant is effective at significantly lower concentrations. Optimizing the application concentration was not a research goal of this project. Figure 5-21 shows testing the amended water delivery system prior to the demolition.

Figure 5-21. Testing amended water flows prior to the demolition.

The system layout consisted of a hydrant equipped with a water meter, nitrile rubber weave construction fire hose, ball shutoff nozzle, and in-line foam 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 by performing periodic 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-half percent. Therefore, following the procedures contained in the NFPA 11 Standard using the Conductivity Method, four standard solutions were prepared using the hydrant water and the surfactant concentrate from the application system. The percent concentrations for the four standards were 0.25, 0.5, 1, and 1.5 based on a target concentration of one-half percent. The conductivity of each surfactant solution standard was then measured and a plot created of the concentration versus conductivity. Figure 5-22 shows the plot serving as the baseline calibration curve for the test series.

The concentration of the surfactant was monitored during the demolition phase of the AACM activities by taking conductivity measurements at a minimum of every four hours 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 5-22. A summary of the conductivity monitoring is presented in Table 5-2. With the exception of two instances, the resulting concentrations based on conductivity measurements of the application flow show that surfactant concentrations ranged from 0.56 to 0.76 percent as compared to a target concentration of one-half percent. This was well within the calibration range of 0.25 to 1.5 percent.

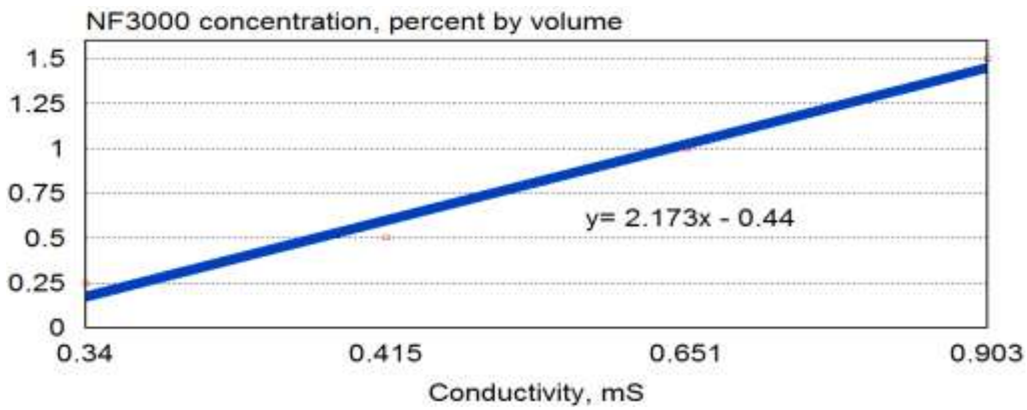

Figure 5-22. Calibration Curve for the NF-3000 Wetting Agent.

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]
07.28.07	0937	Two/15	0.455	0.67
07.28.07	1330	Two/15	0.400	0.56
07.28.07	1500	Two/15	0.500	0.76
07.28.07	1605	Two/15	0.450	0.66

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

Amended water was applied during all phases of the demolition, including pre-wetting, demolition, and the start of the final cleanup process. At the end of the final cleaning, the use of the wetting agent was discontinued and plain water was used to perform the final rinse of the pavement surface.

5.3.1.2 AACM Pre-Wetting

The transite building was pre-wetted on July 27, 2007, the evening before the demolition with a single hose. After the interior was wetted, the amended water was applied to the exterior. This pre-wetting process required about 45 minutes.

On the day of the demolition (Saturday, July 28, 2007), both the interior and exterior were rewetted, taking about one-half hour. Figure 5-23 through Figure 5-27 illustrate this process.

In total, the pre-wetting process required roughly forty five minutes on the day before the demolition and a half-hour on the day of the demolition.

Figure 5-23. Pre-wetting of the transite building the evening before the demolition.

Figure 5-24. Pre-wetting of the transite building the evening before the demolition.

Figure 5-25. Wetting the interior the morning of the demolition.

Figure 5-26. Wetting the interior the morning of the demolition.

Figure 5-27. Wetting the interior the morning of the demolition.

5.3.1.3 AACM Demolition Phase

The demolition of the AACM building was conducted on Saturday July 28, 2007. Amended water was used continuously during the demolition and truck-loading operations. Two 15-gpm nozzles were used to apply the amended water during demolition of the building and debris loading activities.

The trucks hauling the AACM debris to the landfill were lined with two layers of six-mil polyethylene. This lining process took about 15 minutes 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 twenty minutes per truck.

The transite building demolition began at approximately 7:40 am and was completed at 7:30 pm. Site cleanup was completed by 8:00pm. Temperatures that day were near 100 degrees for a significant time, which severely impaired the efficiency of the demolition workers wearing PPE, and required extra break times. The excessive temperatures significantly delayed the completion of the demolition/cleanup activities.

No visible emissions were observed during the entire AACM demolition process.

Figure 5-28 through Figure 5-49 document the AACM demolition process.

Figure 5-28. Delivery the roll-off into the site.

Figure 5-29. Double-lining the roll-offs for hauling of the AACM debris.

Figure 5-30. Starting the AACM demolition.

Figure 5-31. Progressing with the AACM demolition.

Figure 5-32. Demolition barely underway.

Figure 5-33. Transite building about one-third demolished.

Figure 5-34. Refilling amended water supply.

Figure 5-35. Demolition nearly complete.

Figure 5-36. All of the transite building on the ground.

Figure 5-37. Load-out of AACM demolition debris.

Figure 5-38. Load-out the AACM demolition debris (note Velcro).

Figure 5-39. Problems caused by the Velcro stored in the building.

Figure 5-40. More Velcro problems.

Figure 5-41. Burrito-wrapping the roll-off.

Figure 5-42. Removing the roll-off from the containment area.

Figure 5-43. Additional covering before the trip to the landfill.

Figure 5-44. Both types of equipment were useful for debris removal.

Figure 5-45. Final washing of barriers before removal.

Figure 5-46. Collection sump for contaminated amended water.

Figure 5-47. Nearing the completion of the AACM demolition.

Figure 5-48. A tired crew.

Figure 5-49. After completion of the AACM demolition.

5.4 Meteorology During the Demolition

The winds were calm, blowing generally to the east northeast at an average of 2.5 mph with a maximum near nine mph. The temperature averaged 84 degrees with a high of 98 degrees, but it was much hotter for the workers in the PPE. The wind rose for the sampling period is shown in Figure 5-50 and is shown overlaying an aerial view of the site in Figure 5-51, where the traditional prevailing wind closely matched that observed during the test. The location of the background samplers relative to the site and to the wind direction is shown in Figure 5-52.

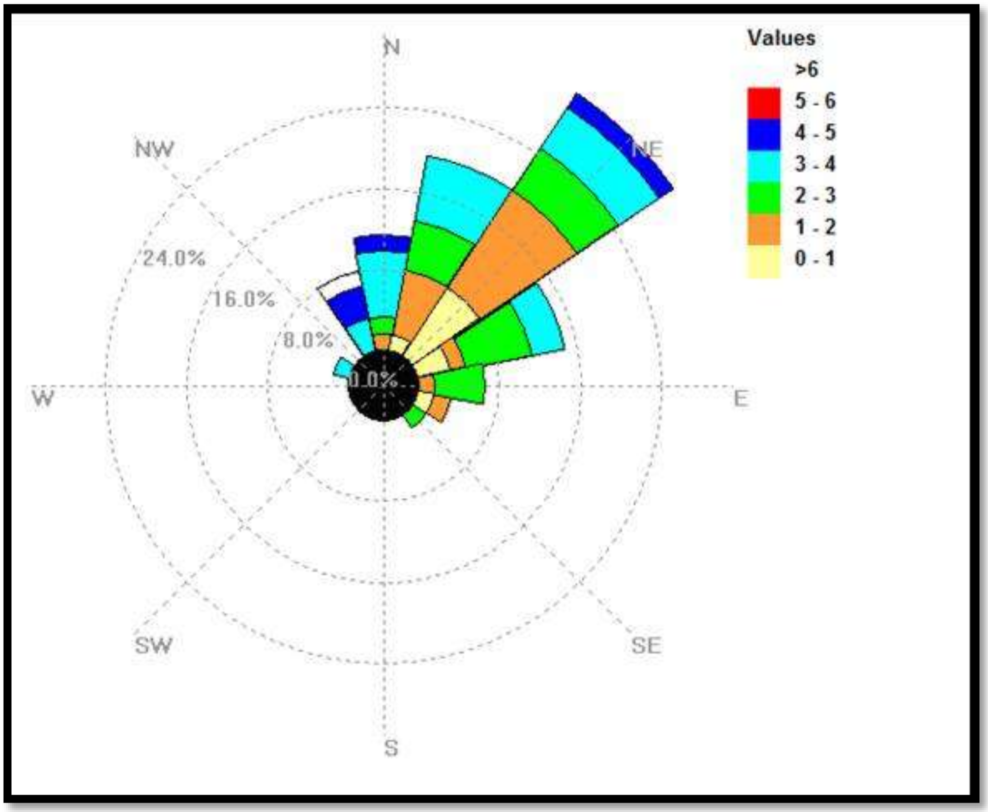

Figure 5-50. Wind Rose during the demolition of the transite building.

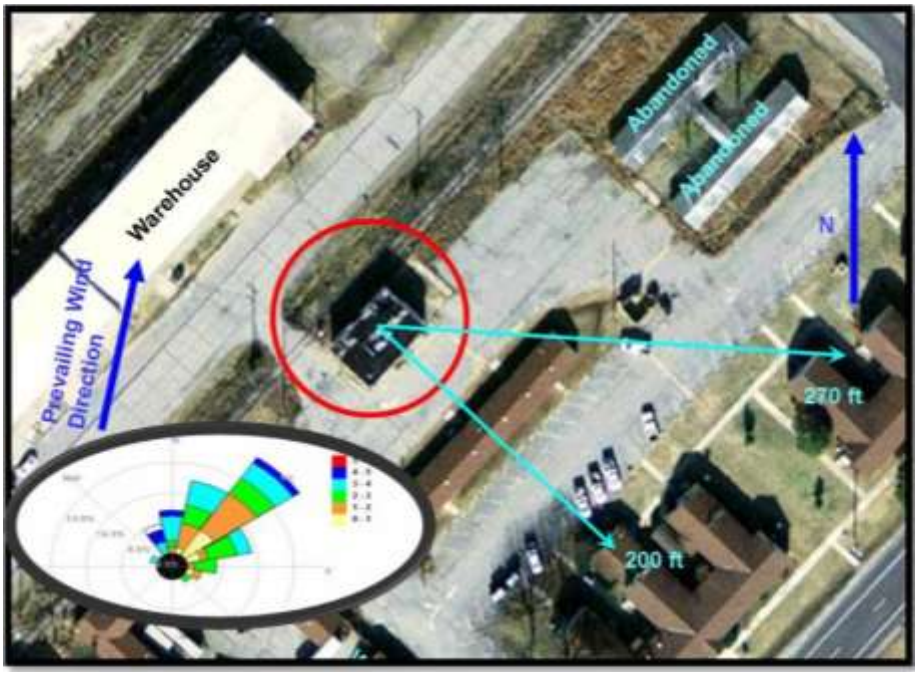

Figure 5-51. Sampling site with wind rose overlay.

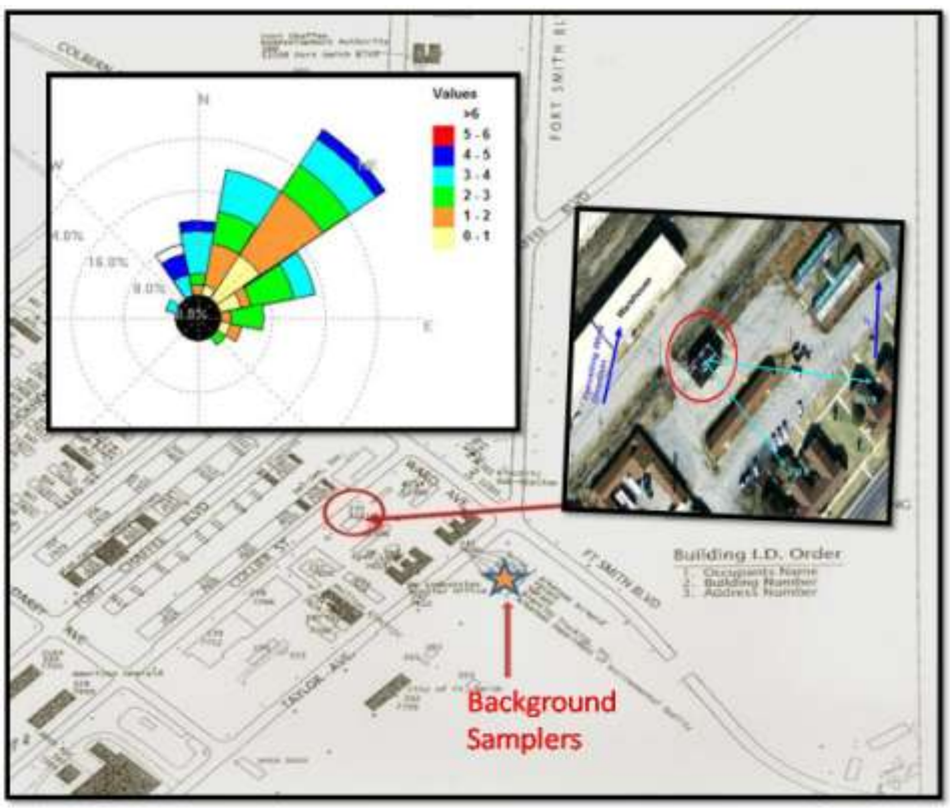

Figure 5-52. Site overlay with wind rose and background samplers location.

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 of approximately four liter/min for the high volume and two liter/min for the low volume samplers. An air volume of 1,920 to 2,400 liters was targeted for high volume samples. 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 and Lead

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 either one or two liters per minute. An air volume of approximately 480 to 960 liters was targeted for these samples.

Lead—Personal breathing zone and work area samples were collected on closed-face, 37-mm-diameter 0.8-µm pore size MCE filters with a cellulose support pad contained in a three-piece cassette. The filter assembly was attached to a constant-flow, battery-powered vacuum pump operating at a flow rate of two liter/min. An air volume of 960 to 1,200 liters was targeted for these samples.

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-minute 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

Collection of surface samples by the microvac technique is shown in Figure 6-1. The spot was marked on the pavement so that before and after samples could be taken near the same location. Pre-demolition pavement samples were collected prior to demolition of the transite 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 where the parking lots were seemingly unaffected by nearby structures with transite siding.

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 was sampled with the microvac. The sampling was conducted with 0.45-micron filters for two-minute 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.

Figure 6-1. Surface sampling on pavement.

6.1.6 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 6-1presents the size ranges of structures that were evaluated, and 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 ≥3:1 and lengths ≥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.

6.2.1.3 Determination of Stopping Point

The analytical sensitivity and detection limit of microscopic methods (such as TEM and PCM) are a function of the volume of air drawn through the filter and the number of grid openings or fields counted. In principle, any required analytical sensitivity or detection limit can be achieved by increasing the number of grid openings or fields examined. Likewise, statistical uncertainty around the number of fibers observed can be reduced by counting more and more fibers. Stopping rules are needed to identify when microscopic examination should end, both at the low end (zero or very few fibers observed) and at the high end (many fibers observed). Table 6-1 identifies the stopping rules used for this study.

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		
Modified ASTM D 5755-03			
- Settled Dust	250 s/cm^2		
- Pavement Dust	1000 s/cm^2		
Modified EPA 100.2			
- Hydrant/Amended Water	0.04 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 five µm in length and with an aspect ratio greater than 3:1 were counted.

The applicable stopping rules in Table 6-1 were used.

6.2.3 Air Samples (Lead)

The 0.8-µm pore size MCE air sampling filters were prepared and analyzed for inorganic lead using NIOSH Method 7300 "Elements by ICP *(Nitric/Perchloric Acid Ashing)."*

6.2.4 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.

6.2.5 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.

6.2.6 Pavement Samples

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 validation.

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 Follow-up Study of the Alternative Asbestos Control Method*, was QA-approved on 07/20/07.

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 (TSA) was conducted at the demolition site at Ft. Chaffee in Ft. Smith, Arkansas. The purpose of this audit was to review the implementation of the QAPP during demolition activities. The audit was conducted by Fernando Padilla, CIH of Science Applications International Corporation (SAIC), through a subcontract agreement with Neptune and Co., Inc., under a Quality Support Contract with the EPA, with oversight by Lauren Drees, the EPA NRMRL QA Manager. The TSA was conducted on July 28, 2007.

The TSA conducted consisted of reviewing sampling methodologies and sample management, field documentation, and interviews of Cadmus onsite personnel. The Cadmus Team personnel interviewed included Ms. Holly Wooten, Task Order Lead; Mr. Seth Shultz, Project Manager, The Louis Berger Group, Inc. (Berger); Mr. Craig Napolitano, Quality Assurance Manager, Berger; and Mr. Ward Phillips, LVI.

This audit consisted of reviewing:

- Sample collection activities
- QA/QC sample collection activities
- Flow meter calibration procedures and records
- Field documentation
- Sample labeling

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	There were some changes made to field procedures described in the QAPP: • The size of spray nozzles used to apply water during demolition was revised. The size of the nozzles was documented in the log book. • The configuration of the sampling ring was revised. Boundaries on south and southeast perimeter were revised to allow truck loading on the SW side of building 235. All samplers remained within 25 to 35 feet from building 235 as specified in the QAPP. The revised layout was documented in log books. • The frequency of checking sampling pumps was revised from once per hour to every two hours. The change of procedure was documented in log books. It was also clarified that flows for personal pumps would only be checked at beginning and end. The personal pumps were checked hourly for functioning and loading. • The criterion for adjusting sampling pump flow rate if flow rate of a pump varied during sampling was revised from +/- 10% to +/- 5%. The change of this procedure was documented in log books.	These changes to the QAPP will be documented in an addendum to the QAPP, including the rationale for the change and the expected impact.
2	For personal samples, pump rotameters, which had been set to 2.0 during initial calibration before use, were used to determine pump flow rates at the beginning of sampling instead of secondary rotameters. At the end of sampling, secondary rotameters were used.	Readings with the pump rotameters set at 2.0 were taken (using clean filters) at the conclusion of sampling with a secondary rotameter and these data were used to determine total sampling volumes. The Berger Project Manager ensured that the correct flow rates were used to calculate total volumes for the personal samples.
3	Sampling data forms were not used to collect sampling data in the field. Data were collected	The Berger Project Manager will ensure that sampling data collected

No.	Observation	Corrective Action
	into log books.	in the log books are accurately transcribed to forms.
4	Background air and settled dust samples were placed 500 feet away from the demolition site at a location expected to be upwind based on meteorological data from previous days. However, meteorological data from the day of the demolition suggested that these samples may not have been truly upwind.	The impact of this will be evaluated when sample results are received.
5	Perimeter samples on barrier wall were removed beginning at 8:30 pm, approximately an hour before site activities were completed. This was necessary for safety reasons so the sampling technician would not need to climb scaffold in the dark to collect the samples.	This will be noted in the final report.
6	At the time of the audit, Chain of Custody forms were largely not completed and not reviewed. The form for the water samples was reviewed and requested only that the samples be analyzed by Method 100.2, which has been modified for this study. No project-specific requirements were noted.	The Berger Project Manager ensured that all COC forms clearly described project analytical requirements and/or referenced the QAPP.
7	Due to the extreme heat and the time required for cleanup, site activities were halted for approximately 90 minutes. Air sampling pumps were stopped during this time.	This will be noted in the final report.
8	The QAPP required that two bottles be collected for each water sample with one "stored for analysis if confirmation of the results obtained from the analysis of the first bottle is required." No second bottle was collected.	This will have no impact unless suspicious results are obtained. This requirement of Method 100.2 will be implemented in future efforts.

7.2.2 Laboratory Audit

The TSA was conducted on August 7, 2007 at the EMSL laboratory facilities located in Westmont, New Jersey. The audit was conducted by Mr. Fernando D. Padilla, CIH of Science Applications International Corporation (SAIC) through a subcontract agreement with Neptune and Co., Inc., under a Quality Support Contract with the EPA, with oversight by the EPA ORD QA Manager, Lauren Drees.

The EMSL personnel interviewed included Mr. Charles LaCerra, Mr. Ed Cahill, Mr. Stephen Siegel, Mr. Daniel Pullman, Ms. Sandy Giff, Ms. Kathy Lusher, Ms. Nancy Smith, Mr. William Chamberlin, Ms. Janet Kaufman, and Mr. Kevin Sparks

The audit focused on the following key areas:

- Project management/QA management of quality affecting activities,
- sample receipt/sample storage,
- chain-of-custody procedures,
- sample analysis procedures,
- laboratory quality control checks,
- laboratory equipment, and
- project-specific data handling and reporting.

Two Findings were identified. The Findings involved incomplete documentation of sample analyses in the laboratory, and the lack of a system to ensure that QC checks required for the project were performed. Several Observations were also identified. These Observations involved sample archiving procedures and minor issues related to analytical processes. A summary of the audit issues and corrective actions is presented in Table 7-2.

Table 7-2. SUMMARY OF TSA ISSUES AND RECOMMENDATIONS

No.	Finding	Corrective Action
1	Documentation of laboratory analyses for project samples is non-existent or incomplete. • EMSL laboratory personnel were not consistently utilizing lab data forms, including prep log sheets and bench sheets, in accordance with established EMSL procedures. In some cases, small pieces of paper were used to document sample preparation information. • Bench sheets and prep log sheets for air and water samples reviewed during the audit did not have analyst name, analysis date, or documentation of water volume filtered. • Project samples for settled dust were prepared in EMSL Westmont lab, and then sent to EMSL San Leandro lab for analysis with original indirect prep log sheets, and copies were not kept in the EMSL Westmont lab. • Lack of proper sample documentation made it difficult to find TEM grids prepared for project water samples during the audit. • Notes kept on grid note sheets for water samples were difficult to read because of smeared and running ink.	Laboratory staff was instructed to ensure that only approved documents are used when recording analytical data. The Assistant Laboratory Manager was instructed to ensure compliance. Laboratory staff was consulted on proper procedures for data recording and completeness of records. Logs, worksheets and forms are completed in their entirety. Following standard procedures, original preparation logs would typically follow the samples when shipped to another EMSL laboratory. Copies of these logs would not normally be maintained by the originating laboratory. However, for this project, EMSL will ensure these logs are copied. Note: Copies of the chain of custody are maintained. This provides for secure sample

		tracking. Preparation technicians and analysts were instructed to comply with the EMSL procedures for the tracking of samples through the analysis process. The Laboratory Management will oversee the labs activities with periodic checks. Laboratory staff was instructed to use only indelible ink when recording analytical data.
2	A system is not in place to ensure that QC checks required for the project, as described in the QAPP, are conducted. • Duplicate samples for indirect analyses (settled dusts, pavement dusts, water) were not prepared at the same time as project samples. In the case of the settled dust samples, rinsate duplicates were not filtered and sent to the San Leandro lab with the samples. • Replicate samples were not requested for project samples using EMSL internal procedures (including a separate count sheet with the sample count sheets). • The project requirement for interlaboratory verified counting and interlaboratory duplicate analysis were not effectively communicated to laboratory personnel.	Following the quality policies, all duplicate samples are currently prepared with the project samples. These include samples that are to be shipped out for analysis to another EMSL laboratory. The laboratory staff has been made aware of and instructed to follow the requirements for quality control analysis. Replicate samples are analyzed following project requirements. Project Management is ensuring that QC analysis is performed in compliance with the program requirements.

No.	Observation	Recommendation
1	The project samples were logged into the EMSL LIMS, and marked with the laboratory default discard date of 9/05/07, rather than their being marked to be held for return to EPA at the end of the project. This deficiency was corrected during the audit.	Corrected at the time of the audit.
2	The laboratory is using NIOSH method 7303 in place of NIOSH method 7300 to analyze personal lead air samples to avoid the hazards to analysts of working with perchloric acid.	The laboratory report cites the method as NIOSH 7300/modified. The modifications are minor and include:

		- use of hot block vs. beaker - perchloric acid not used Quality control analysis (standard control samples, duplicate analysis, matrix spike analysis) indicate that the performance of this modified method is well within acceptance criteria. EMSL believes this method is superior to the 7303 in that the digestion time is longer, providing for better analyte recovery.
3	Asbestos concentrations for preliminary site assessment samples for dust were reported per AHERA method, and ISO 10312 counting rules were not used.	EMSL noted that the ISO counting rules are not necessary for the preliminary site assessment samples.
4	Project requirements include an analytical sensitivity of 0.04 million s/L for source water samples and an analytical sensitivity of two million s/L for surface water samples. The laboratory personnel were not aware of the different requirement for surface water samples. This was clarified during the audit.	Laboratory staff was made aware of the analytical sensitivity requirements. A printed copy of the QAPP was provided to the staff. This was verified during an internal assessment.

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 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 except for one worker sample. Due to the minimal structures that were found, this deviation does not appear to be significant.

Table 7-4. FIELD DUPLICATES FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	Duplicate Result, structures	Variability
TB-Air-M12-4L	TEM	0	0	0
TB-Air-M17-4L	TEM	0	0	0
TB-Work-KeithSampson-2L	TEM	0	7	2.6
TB-Work-OscarGranera-2L	TEM	2	1	0.6

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
TB-Air-M01-4L	TEM	0	0	0
TB-Air-M03-4L	TEM	0	0	0
TB-Air-M05-4L	TEM	0	0	0
TB-Work-DewayneJohnson-2L	TEM	0	0	0
TB-Work-GaryLewis-2L	TEM	8	8	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
TB-Air-M06-4L	TEM	0	0	0
TB-Air-M08-4L	TEM	0	1	1
TB-Air-M10-4L	TEM	0	0	0
TB-Work-JohnniePostock-2L	TEM	0	0	0
TB-Work-GillormoAyala-2L	TEM	0	0	0

[1] Amphibole fiber

7.3.1.6.1 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.

Table 7-7. VERIFIED COUNTS FOR AIR SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Acceptable Variability
TB-Air-M02-4L	TEM	0	0	>80% True Positives <20% False Negatives <20%False Positives
TB-Air-M04-4L	TEM	1	0	
TB-Work-KeithSampson-2L	TEM	0	0	

7.3.1.7 Interlaboratory QA/QC

Interlaboratory QA/QC sample analyses for the air samples included duplicates and verified counts by TEM. After analysis by EMSL, selected filters and grid preparations were sent to Amerisci for analysis as an independent QA/QC check. These results are summarized in Table 7-8 and Table 7-9.

For interlaboratory verified counting analyses, EMSL submitted prepared grids to Amerisci and indicated which specific grid openings were to be examined. The verified counting analyses performed by Amerisci appear to generally confirm the EMSL analyses. However, problems with the grid openings and the minimal structures present in the samples selected for interlaboratory verified counting made the interpretation of the results difficult. Note that the one structure detected by Amerisci for TB-Air-M20-4L was an amphibole. As no other amphiboles were present in any of the other samples/matrices, this is regarded as an anomaly. Additional verified counting analyses were performed in support of the interlaboratory duplicate results and will be discussed later.

Table 7-8. INTERLABORATORY VERIFIED COUNTS

Sample ID	Method	Sample Result	QA/QC Result[1]	Acceptable Variability
TB-Air-M18-4L	TEM	0	0	>80% True Positives <20% False Negatives <20%False Positives
TB-Air-M20-4L	TEM	1	1[2]	

[1]Numerous grid openings were not intact and could not be read.
[2]Amphibole detected.

After analyses by EMSL, they submitted the remaining filters for three samples to Amerisci, who prepared new grids from these filters for analysis. The results for these interlaboratory duplicates were variable. For the three samples, Amerisci's results were consistently higher than the EMSL results.

In order to determine the source of the variability, it was requested that the prepared grids for these three samples prepared at each laboratory be exchanged with the other laboratory to perform verified counting. These results are presented in Table 7-9.

Table 7-9. VERIFIED COUNTS FOR EXCHANGED GRIDS

Sample ID	Method	Sample Result EMSL to Amerisci		Sample Result Amerisci to EMSL		Acceptable Variability
		EMSL	Amerisci	Amerisci	EMSL	
TB-Air-M12-4L	TEM	0	0	10	4	>80% True Positives <20% False Negatives <20%False Positives
TB-Air-M14-4L	TEM	0	0	12	13	
TB-Air-M16-4L	TEM	0	3	26	25	

These results indicated that the variability did not appear to be related to the counting procedures in the two laboratories but pointed to possibly an uneven structure distribution on the filters. Another issue that may have impacted the analyses was the presence of significant particulate loading on the filters, as discussed in the Results section (SECTION 8) of this report. As a result, all of the remaining filter samples were sent to a third laboratory, Bureau Veritas (BV) for preparation of new grids and subsequent analysis. Results for the three laboratories are included in Table 7-10.

Table 7-10. INTERLABORATORY DUPLICATES

Sample Number	**EMSL Results**	**Amerisci Results**	**Variability**	**BV Results**	**Variability**
	Structures Counted			**Structures Counted**	
Perimeter Sampling					
TB-Air-M01-4L	0			0	0
TB-Air-M02-4L	0			1	1
TB-Air-M03-4L	0			0	0
TB-Air-M04-4L	1			1	1
TB-Air-M05-4L	0			0	0
TB-Air-M06-4L	0			4	2.0
TB-Air-M07-4L	0			0	0
TB-Air-M08-4L	0			1	0
TB-Air-M09-4L	0			0	0
TB-Air-M10-4L	0			0	0
TB-Air-M11-4L	0			3	1.7
TB-Air-M12-4L	0	10	3.2	1[1]	1
TB-Air-M12-4L-DUP	0			7	2.6
TB-Air-M13-4L	0			0	0
TB-Air-M14-4L	0	12	3.5	3[1]	1.7
TB-Air-M15-4L	3			18	3.3
TB-Air-M16-4L	0	26	5.1	1[1]	1
TB-Air-M17-4L	0			5	2.2
TB-Air-M17-4L -DUP	0			5	2.2
TB-Air-M18-4L	0			5	2.2
Top of Barrier Wall					
TB-Air-M19-4L	0			0	0
TB-Air-M20-4L	1			0	0
TB-Air-M21-4L	0			0	0
Background					
BG-AIR-M01-8L	0			Unable to Analyze/No Filter in Cassette	
BG-AIR-M02-8L	0			Unable to Analyze/No Filter in Cassette	
BG-AIR-M03-8L	0			Unable to Analyze/No Filter in Cassette	
BG-AIR-M03-8L	0			Unable to Analyze/No Filter in Cassette	

BG-AIR-M05-8L	0			Unable to Analyze/No Filter in Cassette	
BG-AIR-M06-8L	0			0	0

[1]Grids prepared from slide containing carbon-coated filter.

As seen in Table 7-10, the BV results also appear to indicate uneven structure distribution on the filter, with sample counts generally between the EMSL and Amerisci results. Unfortunately, no filter remained for the three original interlaboratory duplicates for preparation and analysis by BV. BV was able to prepare new grids from the EMSL slides containing the carbon-coated fixed filters.

In summary, the observed variability among the laboratories could not be attributed to any specific quality issues. While EMSL results were consistently lower than Amerisci results, the BV results did not consistently confirm the results for either laboratory. As a conservative approach, it was decided that all of the results obtained from the three laboratories needed to be considered during data analysis.

7.3.2 Settled Dust QA/QC

7.3.2.1 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.

7.3.2.2 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 7-11. No variability criteria were established for field duplicates for settled dust samples.

Table 7-11. FIELD DUPLICATES FOR SETTLED DUST SAMPLES

Sample ID	Method	Sample Result	Duplicate Result	Variability
TB-Dust-M10	TEM	1	3	1
TB-Dust-M18	TEM	1	0	1

7.3.2.3 Method Blanks

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

7.3.2.4 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 7-12. All replicate analyses met the acceptance criteria for variability of 2.24.

Table 7-12. REPLICATES FOR SETTLED DUST SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
TB-Dust-M04	TEM	1	0	1
TB-Dust-M09	TEM	13	11	0.4

7.3.2.5 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 7-13. All duplicate analyses met the acceptance criteria for variability of 2.50.

Table 7-13. DUPLICATES FOR SETTLED DUST SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
BG-Dust-M03	TEM	0	0	0
BG-Dust-M05	TEM	4	3	0.4

7.3.3 Water QA/QC Results

7.3.3.1 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.

7.3.3.2 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 7-14. Note that the QAPP did not identify any specific variability requirements for water field duplicates.

Table 7-14. FIELD DUPLICATE FOR WATER SAMPLES

Sample ID	Method	Sample Result, structures	Duplicate Result, structures	Variability
TB-HW-01	EPA 100.2	9	0	3.0
TB-AW-01	EPA 100.2	2	0	1.4
TB-AWSURF-01	EPA 100.2	105	100	0.3

7.3.3.3 Method Blank

The method blank had a non-detected asbestos concentration of <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 the replicate are presented in Table 7-15. The replicate analysis met the acceptance criteria for variability of 2.24.

Table 7-15. REPLICATE FOR WATER SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
TB-HW-02	EPA 100.2	0	0	0

7.3.3.5 Duplicates

A duplicate analysis is the analysis of a second aliquot of the original water sample. Results for the duplicate are presented in Table 7-16. The duplicate analysis met the acceptance criteria for variability of 2.50.

Table 7-16. DUPLICATE FOR WATER SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
TB-AWSURF-02	EPA 100.2	103	102	0.1

7.3.4 Pavement Dust QA/QC

7.3.4.1 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.

7.3.4.2 Method Blanks

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

7.3.4.3 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. Results for replicates are presented in Table 7-17. All replicate analyses met the acceptance criteria for variability of 2.24.

Table 7-17. REPLICATES FOR PAVEMENT SAMPLES

Sample ID	Method	Sample Result, structures	QA/QC Result, structures	Variability
TB-PAVE PRE-02-2L	TEM	11	7	0.9
TB-PAVE PRE-04-2L	TEM	2	0	1.4
TB-PAVEPOST-01-2L	TEM	0	0	0
TB-PAVEPOST-08-2L	TEM	0	0	0

7.3.4.4 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 7-18. All duplicate analyses met the acceptance criteria for variability of 2.50 except for one pavement sample.

Table 7-18. DUPLICATES FOR PAVEMENT SAMPLES

Sample ID	Method	Sample Result	QA/QC Result	Variability
TB-PAVE PRE-01-2L	TEM	13	32	2.8
TB-PAVE PRE-08-2L	TEM	2	0	1.4
TB-PAVEPOST-03-2L	TEM	0	0	0
TB-PAVEPOST-05-2L	TEM	23	18	0.8

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

With only a few minor deviations, the QA/QC results for the settled dust, water, and pavement samples were acceptable and these results can be used with confidence in making project decisions. For the air samples, some interlaboratory variability was observed, and the source of this variability could not be identified. ***As a conservative approach, the QA manager and the Project Manager agreed that results from all laboratories be considered in the data analyses and project conclusions.***

SECTION 8 Results

The results obtained for samples collected during the demolition are provided in this section, including process monitoring. Detailed inferential statistical discussions are provided in SECTION 9. The cost analysis is provided in Section 8.9.

The majority of airborne asbestos data yielded non-detects at very low limits of detection (the detection limit was 0.0015 s/cm^3 or 2.99 times the analytical sensitivity of 0.0005 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 60 percent of the air samples for asbestos during the AACM2 demolition were non-detect at 0.0005 s/cm^3 analytical sensitivity. All but five were at or below the limit of detection of 0.0015 s/cm^3; the highest concentration above the limit of detection was 0.00519 s/cm^3 for the perimeter samples and 0.15 s/cm^3 for the background samples (but the 0.15 s/cm^3 average included one sample that was analyzed by the indirect method).

The statistical analyses for AACM2 were initially complicated by the fact that the extreme heat and other factors produced an unexpectedly long demolition and resulted in some of the filters being overloaded. This was further complicated by some fairly large differences between results reported by the three analytical laboratories that were used in the effort to produce the data and to evaluate the quality of the data. Detailed explanations of these occurrences are in the Quality Assurance/ Quality Control Section of this report (Section 7.3) and explanations of the way that the data were handled and reported are in 8.2.2 and in the Inferential Statistics discussion (SECTION 9).

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

Some of the analyses for the background air samples were done indirectly because of overloading. It is difficult to directly compare the results of indirect analyses with those of direct analyses. Invariably, the indirect analyses yield higher asbestos counts. Nonetheless, indirect analytical results give very useful information in evaluating the presence of asbestos fibers when they are detected.

To summarize:

- For descriptive statistics, a value of zero was substituted for non-detects. For the airborne asbestos concentrations, results from two and sometimes three laboratories are available for each air sample. An average value was calculated for each sample station based upon the analytical results available for that particular sample site. If the average value were below the analytical sensitivity, less than the analytical sensitivity was shown in the data table in the appendix (Table 13-3) and was used as a zero for the descriptive statistics only.

- For the inferential statistics for the air samples, an explanation is available in the Inferential Statistics Section as to how those data were handled to perform the inferential statistical tests.

- 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.

- 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 between five- and 90-percent non-detect data, nonparametric methods based on ranks and adjusted for ties were employed.

- In cases where there were greater than 90-percent non-detect data for either method, no statistical analyses were conducted.

8.1 Demolition Activities

The demolition activities for AACM2 were not as efficient as anticipated. Several problems were encountered:

- The Velcro stored in the building seriously hampered loading the debris into the roll-offs as stringers of Velcro consistently needed to be cut by hand to enable the load to be deposited into the roll-off.

- Very hot working conditions seriously hampered worker effectiveness and significantly prolonged the demolition.

- The process of lining the roll-offs was initially inefficient as they performed that task in the containment area and this delayed the loading by about 20-30 minutes per roll-off. Later, the demolition contractor began lining the roll-offs outside the containments, which was far more expeditious.

8.2 Air

Figure 8-1 shows the perimeter sampler layout surrounding the building. Table 8-2 presents the descriptive statistics for the airborne asbestos concentrations measured during the demolition, debris removal, and final cleanup of the transite building. The individual sample results are contained in Table 13-3 of the Appendix and discussions of the QA/QC observations and resolutions important to understanding these data are presented in Section 7.3.1. Because the demolition took far longer than anticipated, many of the eight-liter/min samples could not be analyzed by the direct method as they became overloaded with particulate; therefore the four-liter/min samples were preferentially analyzed and reported in Table 13-3 of the Appendix and were used for the data analyses in this section of the report. Also, a few of those four-liter samples were observed by one of the three laboratories involved in this study to be loaded in excess of the QAPP requirements (20-percent overloading as the upper limit) but the decision was made to analyze them by the direct method. One of the labs (Bureau Veritas) performed a water bath dissolution step to attempt to clear the filters that they judged to be overloaded. All these variables probably contributed to the disagreement between laboratories on the asbestos concentration: however, the choice was made to average the values from the different labs for each individual sample site to obtain asbestos concentrations for use in the descriptive statistics.

To summarize, for the descriptive statistics TEM air concentrations, the values presented for each sample location reflect an average of values from as many as three laboratories, necessitated by QA/QC variances that exceeded the acceptable range designated in the QAPP. The averaging of the individual concentrations from the separate laboratories was done to be environmentally conservative. If the average was below the analytical sensitivity, the analytical sensitivity was used as the average concentration. The averaged individual asbestos concentrations are illustrated in Figure 8-2, and each separate concentration is listed in Table 13-7 of the Appendix.

Table 8-2. AIRBORNE ASBESTOS (TEM) DURING DEMOLITION OF THE TRANSITE BUILDING

Sample Location (Position and Height)		Total Asbestos				PCME Asbestos			
		n/N[a]	Mean[b] (s/cm^3)	Min (s/cm^3)	Max (s/cm^3)	n/N[a]	Mean[b] (s/cm^3)	Min (s/cm^3)	Max (s/cm^3)
Demolition and Debris Removal									
Background	5-ft	1/6	0.02500	0	0.15000	0/6	0	0	0
Ring	10-ft	10/18	0.00109	0	0.00519	2/18	0.0001	0	0.00048
Top of Wall	25-ft	0/3	0	0	0	0/3	0	0	0

[a] Denotes number of samples at or above analytical sensitivity/total number of samples. The analytical sensitivity ranged from 0.0086(indirect) 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.

In each grouping of samples presented in Figure 8-2, the samples are in numerical order in the manner in which the samplers were placed around the buildings (Figure 8-1). That is, the first sample in the group of 18 corresponded to the location on the left-rear (as seen from the parking lot) corner of the building and then were numbered in a clockwise fashion around the structure. Samplers two through five were in front of the barrier wall that was next to the railroad tracks. The roll-offs entered the containment area between samplers one and two and were loaded along the left side of the building (next to samplers 16 through 18). Accumulated water on the pavement was pumped from a sump constructed in the pavement next to sampler 15, which was the low point for drainage from the paved area.

Visually, there does appear to be a correlation between sample location and the small concentrations of asbestos observed in the air samplers. Small amounts of asbestos were detected generally adjacent to the side where debris was loaded, near the sump where the pump frequently clogged and had to be raised to clean it, and in the generally downwind direction. The wind was consistently blowing from the right to the left of the building, as illustrated in Figure 5-51.

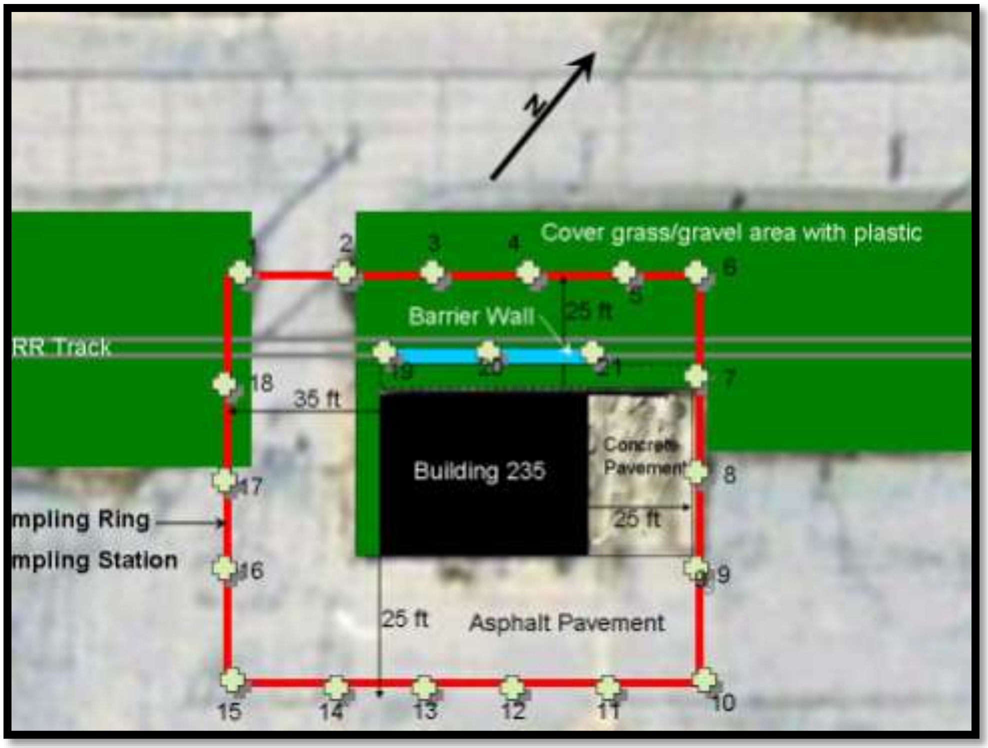

Figure 8-1. Sampler locations around the transite building.

Almost all of the airborne asbestos concentrations observed were *near or below the limit of detection, which was 0.0015 s/cm^3 (2.99 times the analytical sensitivity of 0.0005 s/cm^3).* Only five samples exceeded the limit of detection, with the highest total asbestos concentration being 0.0052 s/cm^3. That particular sample was station 15, which was located immediately adjacent to the sump where the accumulated water was pumped from the containment. There were several instances when the intake area of the pump that was located in a sump in the pavement became clogged with debris and had to be lifted on top of the containment barrier to be cleaned.

The statistical analyses are presented in Section 9.1 and are restricted by the differences in laboratory results and by the fact that some laboratory samples for the background samples were overloaded and required indirect analysis, which are not directly comparable with direct analysis results. Therefore, only the direct analysis results were used for the inferential statistical analysis. Overall, the statistical analyses concluded that there were differences in results from the different laboratories. Using Bureau Veritas results, the inferential statistics indicated *since the BKGD MDL was below the lower limit of the confidence interval (0.00057 s/cm^3), one would conclude it was significantly different than the mean Bureau Veritas AACM concentration of 0.0014 s/cm^3*. Using the EMSL results, however, the statistical conclusions were that *one would conclude there was no difference in the probability of observing a censored value in the AACM and BKGD EMSL data sets.*

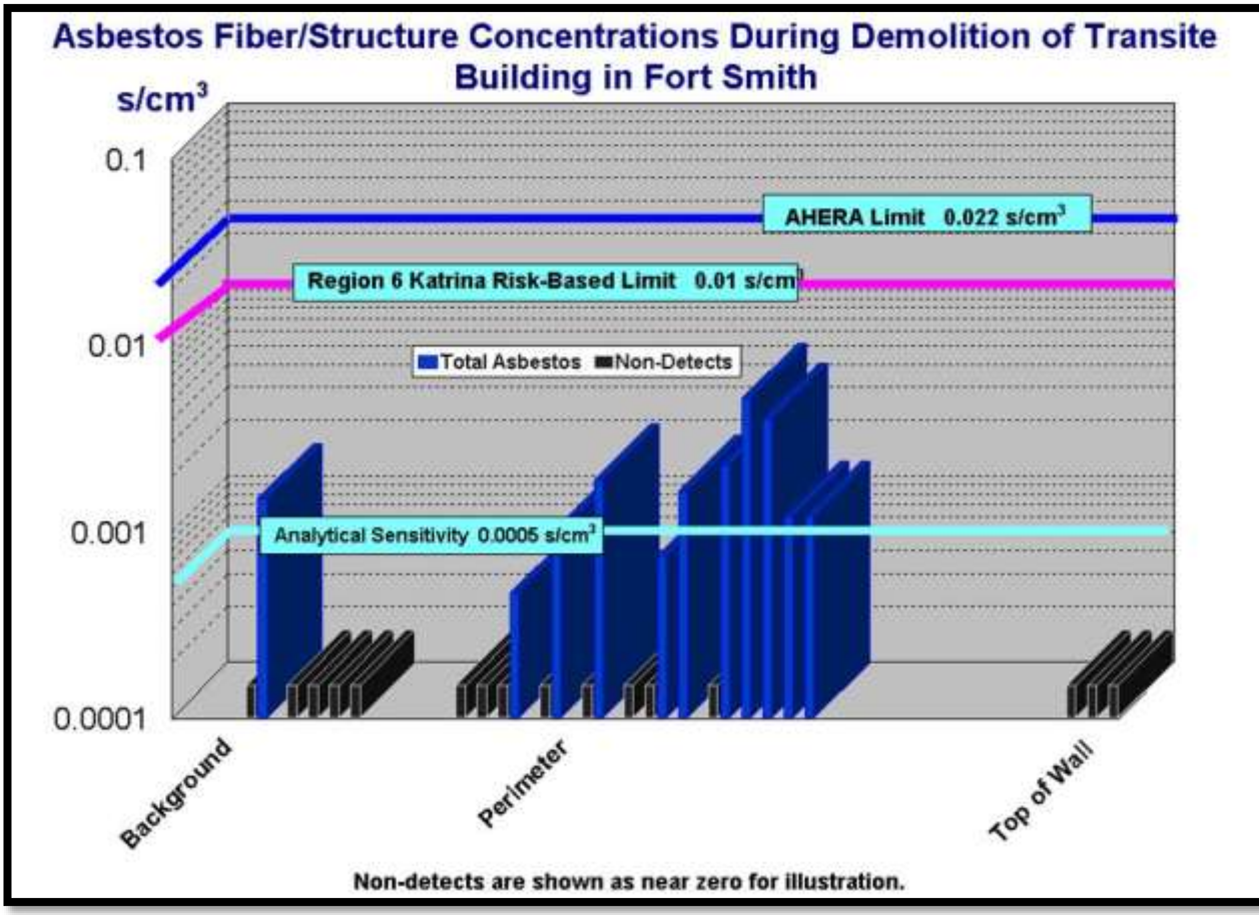

Figure 8-2. Airborne asbestos concentrations (TEM) for AACM2.

None of the three samplers located on top of the barrier wall detected asbestos.

8.2.1 PCM Fiber Concentrations

The Phase Contrast Microscope results for the transite building demolition are presented in Table 13-3 of the Appendix. While PCM values do not distinguish between asbestos and a variety of other fibers, they are normally indicative of the effectiveness of the wetting controls as to overall fiber release for typical demolitions; however, there were minimal fibrous materials present in the transite building, and there were no fibers observed by PCM in all but one of the perimeter samples.

8.2.2 Perimeter Air Asbestos Summary

All of the airborne asbestos concentrations observed were *near or below the limit of detection, which is 0.0015 s/cm^3*. Only five samples exceeded the limit of detection, with the highest total asbestos concentration being 0.005 s/cm^3. These concentrations are significantly less than AHERA (40 CFR §763) clearance criterion (0.022 s/cm^3). Only two of the 18 perimeter samples observed PCME-size asbestos fibers (one fiber per sample or 0.00048 s/cm^3), 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 (0.005 s/cm^3) was equal to 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 8-2) demonstrate that the AACM2 demolition protocol was effective in controlling the release of airborne asbestos.

8.3 Visible Emissions

EPA staff observed no visible emissions during the entire AACM2 demolition process.

8.4 Dust

Table 8-3 presents the descriptive statistics for the settled dust samples collected during demolition of the transite building. The individual sample results are contained in Table 13-6 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 TRANSITE 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
Demolition, Debris Removal, and Cleaning							
Background	2/6	194	0	958	13	0	63
Perimeter	13/18	813	0	3980	54	0	252
Top of Wall	1/3	913	0	2740	60	0	181

[a] Denotes number of samples at or above analytical sensitivity/total number of samples. The analytical sensitivity ranged from 211 to 234 s/cm^2.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

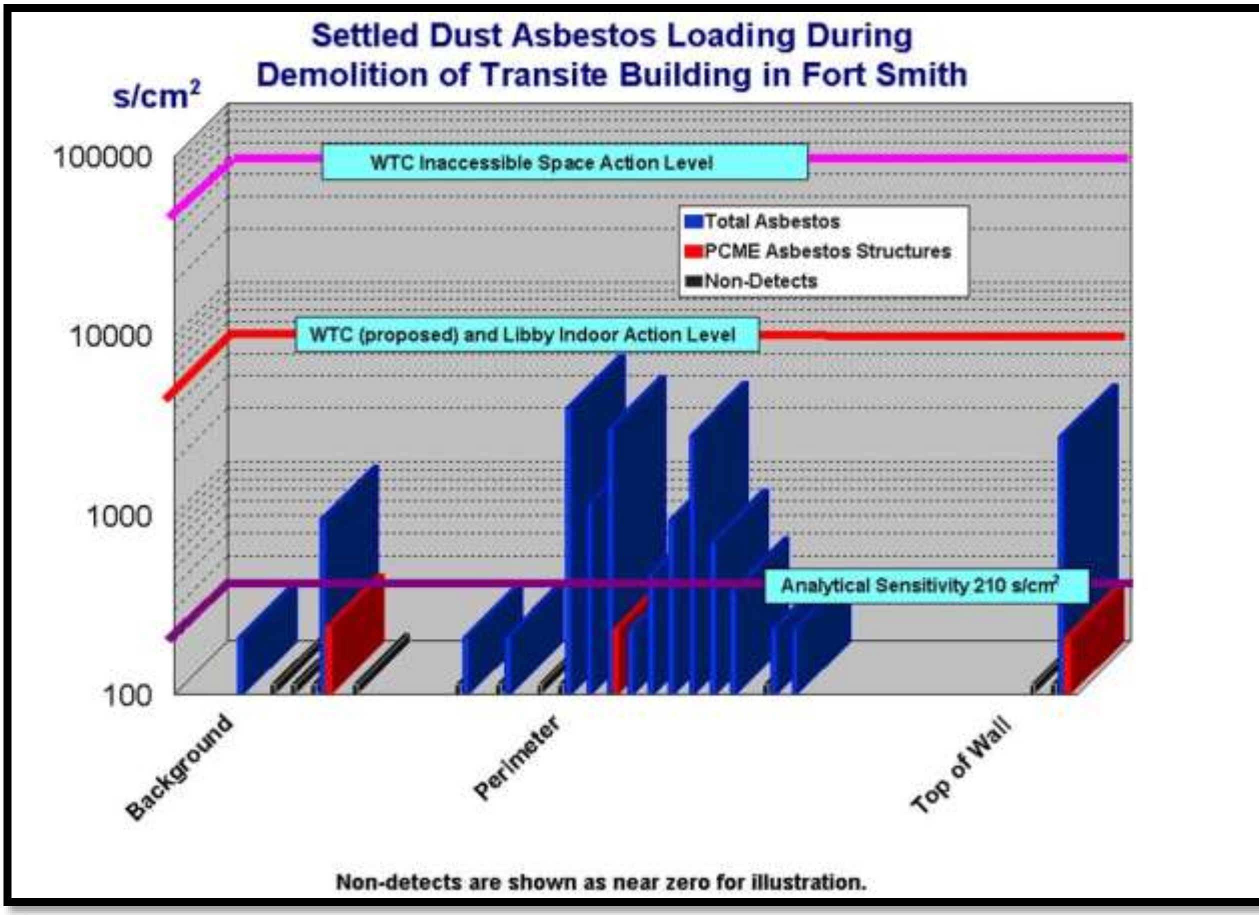

Figure 8-3. Settled dust loadings from the transite building demolition.

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. Two of the six background dust samplers located many hundred feet upwind detected asbestos at fairly low loadings (<1000 s/cm^2). These samplers were co-located with the 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. One of the three settled dust samples on top of the barrier wall had asbestos in the settled dust; this is in contrast to the air samples at the same locations, which only had non-detects.

There was no statistically-significant increase in the settled dust asbestos concentrations comparing the background with the perimeter, although the perimeter data certainly appear to be higher than the background in Figure 8-3. *The statistical analyses (Section 9.2.2) indicated one would fail to reject the null hypothesis of no difference in the asbestos concentrations in the settled dust (TEM s/cm^2) for AACM and BKGD. Although due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted, it appears the (Kaplan-Meier) mean concentration of asbestos in the AACM settled dust (871 s/cm^2) was greater than BKGD (335 s/cm^2).*

8.5 Pavement Surface

Individual pavement surface data are summarized in Table 8-4, presented in Table 13-4 of the Appendix, and are shown graphically in Figure 8-4.

Table 8-4. PAVEMENT SURFACE SAMPLING

Sample Description	**Total Asbestos Loading, s/cm^2**			
	n/N[a]	**Mean[b]**	**Min**	**Max**
Site Assessment	4/4	1,233,000	500	2,700,000
Background	1/4	235	0	938
Pre-demolition	6/8	4,059	0	10,400
Post-demolition	1/8	2,488	0	19,900

[a] Denotes number of samples at or above analytical sensitivity/total number of samples. The analytical sensitivity ranged from 211 to 234 s/cm^2.
[b] Calculated based on the use of zero for values less than the analytical sensitivity.

The pavement surface samples illustrate some very important environmental concerns about the impact of weathering transite-covered structures on the areas surrounding them. When the site assessment samples were taken about two months before the study occurred, there were four pavement samples acquired; two within several feet of the building and two about 25-ft away. The two that were next to the building indicated asbestos surface loadings of 2,200,000 and 2,700,000 s/cm^2 respectively. The more distant samples contained surface loadings of 30,000 and 500 s/cm^2 respectively. The importance of these data is that it is indicative of the erosion of the transite from weathering and the resulting contamination of the surrounding area.

The paved surface in front of the transite building was subject to limited but frequent vehicle traffic through the parking area. It is certainly possible that this vehicle traffic across the contaminated surface could have been a consistent source of airborne asbestos to the vicinity.

Between the time of the site assessment sampling and the study, the area was subjected to a series of extreme rainfall events and severe flooding in the Arkansas area. As seen in the pre-demolition loadings in Table 8-4 and Figure 8-4 and Figure 8-5 , the surface loadings had been significantly reduced by the time of the study, with six of the eight samples detecting asbestos but the highest loading was 10,400 s/cm^2, meaning that the majority of the asbestos present in the site assessment sampling had been washed from the pavement by the rainfall events and was now probably in the soil downgradient from the pavement surface.

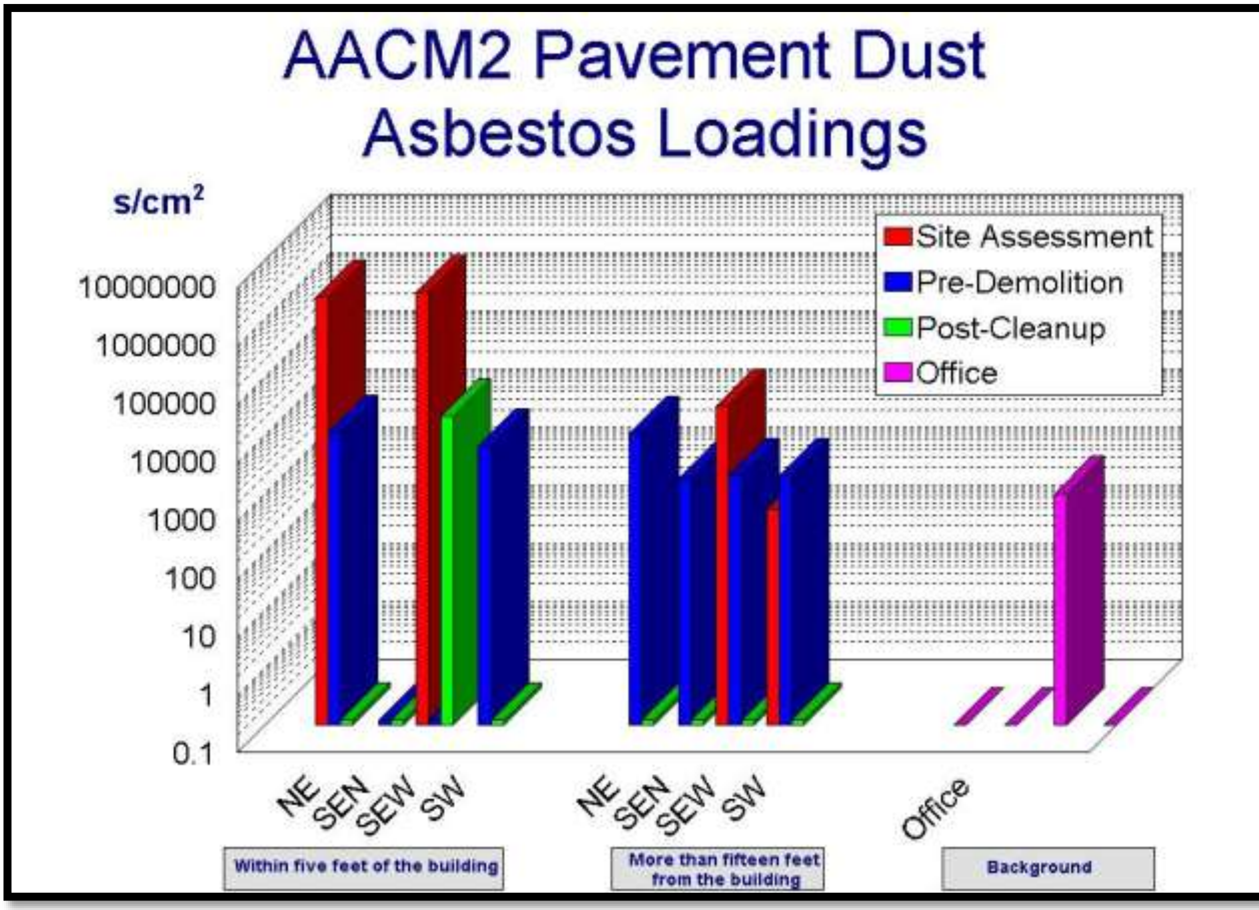

Figure 8-4. Pavement surface sampling results from the transite building demolition.

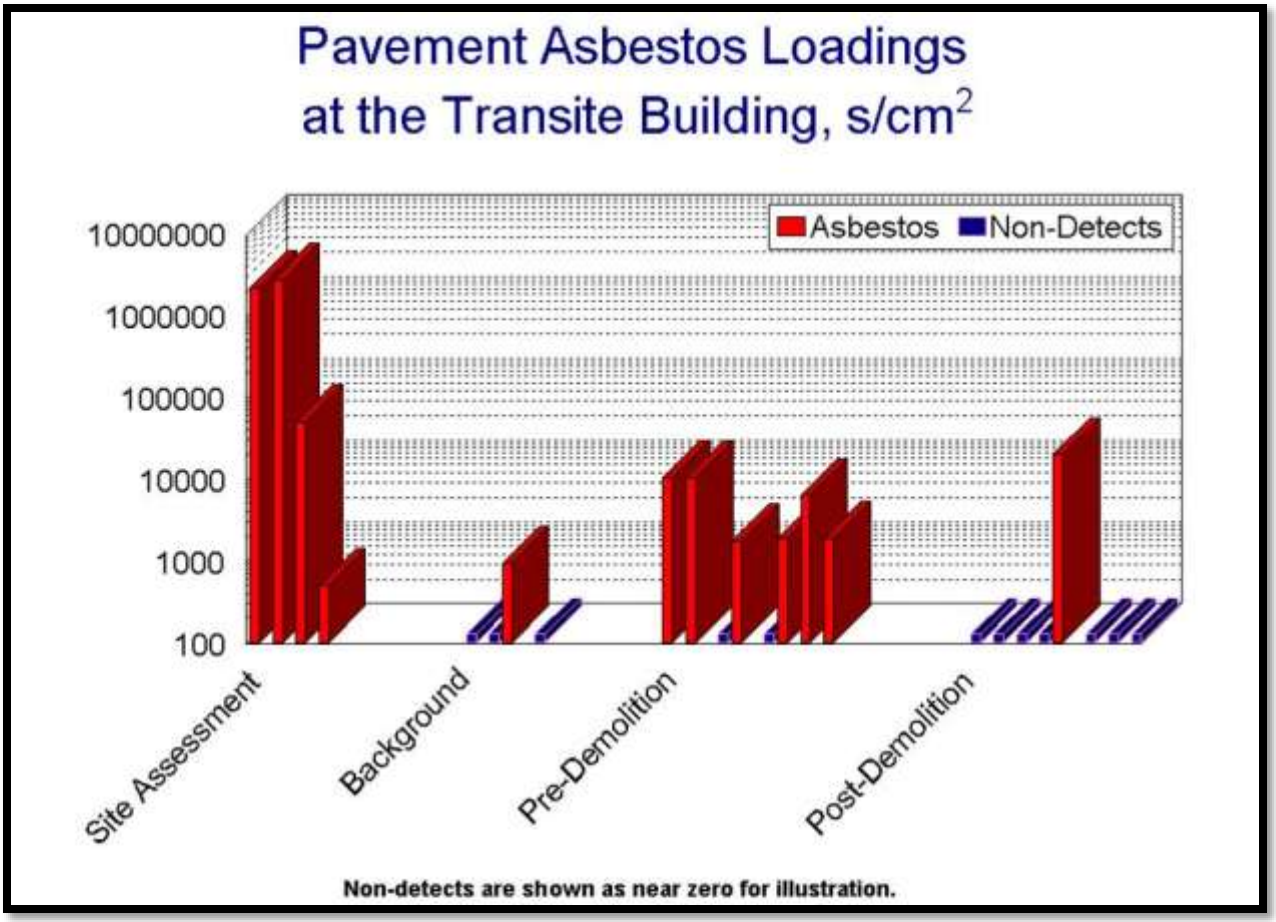

Figure 8-5. Pavement asbestos loadings at the transite building demolition.

The application of the AACM technology to the demolition of the transite building resulted in the post-demolition samples having only one of eight samples detecting asbestos. If the NESHAP process had been used to demolish the building, there would have been little or no reduction in the asbestos loading on the pavement surface.

The statistical analysis (Section 9.2.3) indicated that one would conclude there was a difference in the probability of observing a censored value in the pre- and post-demolition data sets; i.e., one is more likely to observe a censored value in the post-demolition data.

8.6 Water

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

The amended water was applied at the nominal concentration of 0.5 percent as verified by the conductivity sampling using two firehoses operating at approximately 15 gpm each.

Overall, about 12,000 gallons of water were applied during the entire process, from pre-wetting, demolition/debris disposal, and ultimately equipment decon and final cleaning. Approximately 60 gallons of the NF-3000 wetting agent were used during the study to achieve the 0.5-percent amended water concentration. Little water was absorbed by the debris during AACM2, since there was little absorbent material in the building. Likewise, since AACM2 was on pavement, there was virtually no infiltration. Most of the water applied was therefore captured and was later filtered and discharged to the sanitary sewer.

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

Phase of Demolition	Hydrant Meter Reading (ft^3)		Source Water Usage	
	Start	Stop	ft^3	Gallons
Wetting thru Cleanup	178092	179721	1629	12186

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. Complete analytical results are presented in Table 13-5 of the Appendix. The analytical results indicate that pooled surface water collected from inside the berm contained significant concentrations of asbestos. This result is consistent with the design of the AACM process that envisioned that a significant amount of the asbestos released during the demolition process would be trapped in the amended water, thus necessitating capture of that water and /or removal of soil where applicable. The water in this test was all captured and filtered before ultimate disposal. Where soil exists around a 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. There was no soil impacted by this demolition at this particular site. Neither water capture or soil removal are required with the existing NESHAP process.

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. As shown in Table 8-6, the mean surface water asbestos concentration >10μ is roughly 200 times the drinking water MCL.

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

Sample Description	Asbestos Concentration, million s/L							
	>10µ				Total			
	n/N[a]	Mean[b]	Min[b]	Max[b]	n/N[a]	Mean[b]	Min[b]	Max
Source Hydrant	0/2	0	0	0	1/2	0.09	0	0.35
Applied Amended Water	0/2	0	0	0	1/2	0.03	0	0.08
Surface Water	3/3	1,240	2.5	3,500	3/3	42,000	260	120,000

[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 Workers

Workers were monitored during all phases of the study. Individual sample results are presented in Table 13-7 and are summarized in Table 8-7. The demolition worker samples were analyzed by TEM and by PCM (Table 8-7). Five of the seven worker breathing zone samples were non-detect for total asbestos (all asbestos structures >0.5 microns in length and ≥3:1 aspect ratio) at the 0.001 s/cm^3 analytical sensitivity level. Overall, none of the worker samples showed detectable PCME asbestos structures (>5 microns in length and ≥3:1 aspect ratio) during the demolitions. The two worker samples that showed detectable asbestos had breathing zone asbestos concentrations of 0.006 and 0.002 s/cm^3 respectively.

Consistent with the perimeter air sampling results, since there was practically no fibrous material in the building, only one of the six workers had PCM fibers observed on their breathing zone filters, and that concentration was 0.003 f/ cm^3. Time-weighted averages, based upon the PCM fiber counts above, were therefore 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 TRANSITE 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
Demolition/ Debris Disposal/Cleanup												
All	2/7	0.001	0	0.006	0/7	0	0	0	1/7	0.0004	0	0.003

[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.

The extremely low worker breathing zone asbestos concentrations offer a significant advantage for the AACM2 technology.

8.8 Time

The construction of the water containment process, which including cutting a kerf into the pavement, ringing the downgradient area with hay bales, tucking plastic into the kerf and sealing it with caulking, and applying some waterproofing to the asphalt surface immediately in front of the kerfed area, took about one-half day. The pre-wetting of the transite building was accomplished the evening before the demolition and took about 45 minutes. The demolition took place in its entirety the following day. The demolition itself was slowed significantly by the extreme temperatures on that day that resulted in work area temperatures above 100 degrees; therefore asbestos-worker heat stress in the Tyvek clothing and respirators was a constant worry and the demolition proceeded at a very slow pace. Initial estimates of the time required to demo the structure and load out the debris were on the order of six-hours maximum. It required over twelve hours to accomplish the task, including time for extended worker breaks. As stated before, rolls of Velcro that were stored in the building hampered loading and frequently had to be cut by hand to free the track-hoe bucket. Also, the process of lining the roll-offs was initially done within the containment zone and the track-hoe was required to be idle while the contractor lined the roll-offs. This was later remedied by lining the roll-offs before they entered the site.

Filtering and disposal of accumulated water was done the morning following the demolition and took one-half day; therefore, the total time for the application of the AACM process at this site was two days.

8.8.1 Estimated NESHAP

If the building would have been demolished by the standard NESHAP practice, the first phase by the abatement workers would have been to carefully remove the transite siding panels and place them in double bags. It is estimated that this process, in the same heat, would have required two days to complete.

Demolition of the structure and debris cleanup would have then been accomplished in an additional day, being somewhat faster since the workers would not have been wearing PPE. Workers would not have been required to line the roll-offs or to use two firehoses to wet the structure.

The total NESHAP time is therefore estimated at three days versus two days for the AACM2 demolition. Again, the NESHAP process would not have required decontamination of the pavement surface.

8.9 Cost

The costs associated with the building demolition was 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,
- creation of a berm to collect runoff water, and
- collection and processing of runoff water.

8.9.1 Methodology

A total cost accounting for the demolition effort was performed. In order to provide the most accurate accounting of the cost to perform this demolition, 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, scaffolding wall), 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) 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.
- Adding additional transite panels onto the structure.
- Construction of a scaffolding wall.
- 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 Chaffee, Arkansas. For similar demolition activities performed in other locations, the cost may increase or decrease depending on local conditions, the distance to reach an approved asbestos landfill and the competitiveness of firms offering these services.

8.9.2 Cost Items

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

8.9.2.1 Pre-Demolition Asbestos Compliance Inspection

A pre-demolition asbestos compliance inspection was required and performed by Environmental Enterprise Group, Inc. (EEG) an Arkansas Department of Environmental Quality (DEQ) Licensed Asbestos Consultant. The cost was approximately $1,800 and included the collection and analysis of twenty-one bulk samples and one TCLP sample.

8.9.2.2 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 12 hours. Site personnel including workers and supervisor were billed at a rate of $37.50/hour and $55/hour respectively and are based on the reported hours on invoices. Total hours worked can be broken down to 26 hours of supervisor time and 104 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 4:00 P.M. on a Friday, July 27, 2007. Actual building demolition and debris loading was performed on Saturday, July 28th, 2007. Additional site cleanup and equipment loadout was performed part of the day on Sunday, July 29, 2007 and Monday, July 30, 2007.

8.9.2.3 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 Smith. Hydrant charges over the test program were $103.35 including taxes and applicable surcharges. The cost of the wetting agent was based on the approximately 60 gallons of surfactant used and was about $740 at the $12.40 per gallon cost. Other wetting agents probably work as well and cost considerably less.

8.9.2.4 Demolition Debris Disposal

The asbestos contaminated C&D debris from the job site was taken to the Fort Smith Sanitary Landfill – Fort Smith, Arkansas. The cost of disposal at this landfill was roughly $34 per ton. 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 35 tons was generated during the demolition in four roll-off boxes for a cost of roughly $1,200. There was also a fuel surcharge at the landfill of approximately $525 that brought the total cost of disposal to $1,725.

8.9.2.5 Trucking Costs

The costs of transportation and disposal include the trucks, truck drivers, roll-off box rental, and fuel for the transportation of asbestos-contaminated debris from the job site to the Fort Smith Sanitary Landfill – Fort Smith, Arkansas. Field notes, landfill invoices, disposal manifests, and contractor invoices were reconciled to determine disposal costs. Trucks used in this effort were owned and operated by Global Environmental Waste, Inc. The billing rate for the truck, truck driver and roll-off box rental was $295 per hour. There were three truck drivers and trucks, one of which made two trips to the landfill. Due to agreements with the local authorities this projects was conducted over the weekend in order to minimize impacts to surrounding businesses. As a result of this, special arrangements had to be made with the landfill in order for them to be open on one of their non-business days. Trucks were therefore kept onsite with drivers to facilitate completion of the project in one day. Additional delays due to weather and the research-oriented aspects of this project also incurred additional charges that have not been included here for the purpose of the cost evaluation. By using roll-off containers, one truck and truck driver would have normally been expected to be on-site to position roll-off containers during demolition and demolition debris loading. The total cost of trucking was $5,855 which is based on two hours to drop off and stage the containers, ten hours of standby time during demolition to move the roll-off boxes around, and four hours to haul the containers to the landfill.

8.9.2.6 Supplies

The project required various miscellaneous supplies including caution tape, Tyvek® coveralls, sorbent booms, decon brushes, polyethylene sheeting, duct tape, spray foam, spray adhesive, hay bales, rubber roofing, etc.

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. No lining would have been done for the C&D debris that would have resulted from demolition of the building after the NESHAP abatement. Poly sheeting was also used in to create a water-tight berm on three sides of the site building in conjunction with the grade of the parking lot to collect all the runoff water. The total cost for poly sheeting was approximately $1,300 and labor costs for lining and sealing were included under the demolition labor. The hay and rubber roofing used to create the berm were roughly $1,200. An additional $1,000 were spent on the remaining supplies, temporary toilet facilities etc. All supplies were subject to local sales tax plus a 15%-markup from the primary contractor. The total cost of supplies for this project was estimated to be $3,500. It should be noted that the cost of supplies were higher for AACM2 compared to the NESHAP methodologies as additional poly sheeting was required to create a water-tight berm around the subject building in order to properly collect the runoff water.

8.9.2.7 NESHAP Abatement Cost Estimate

The estimate for the abatement cost was supplied by Environmental Enterprise Group, Inc. (EEG), an Arkansas Department of Environmental Quality (DEQ) Licensed Asbestos Consultant and was based upon their knowledge and experience in the local Arkansas area.

8.9.3 Applicability of the costs to different sites

The costs for this demolition in Fort Smith, Arkansas are very site specific and may vary at other sites according to building type, size, asbestos type and extent, etc. The landfill used for this project was approximately ten miles from the job site which is unusually close to the project site which cut down on transportation costs; however it should be noted that the landfill used for this project is one of the more expensive in the state.

8.9.4 NESHAP Imminent Danger Demolition

The cost associated with the survey and design for the NESHAP building in danger of imminent collapse is lower compared to the other scenarios costs due to limited access to the interior and the roof which would not be possible to sample, thus reducing the number of samples collected and the amount of time spent during the field survey.

Similarly, the costs for disposal at the landfill are projected to be lower because a contractor would typically pack the roll-off container much more aggressively.

8.9.5 Summary

Table 8-8 presents the cost of AACM2 using disposal at the Fort Smith Landfill.

Table 8-8. AACM2 BUILDING DEMOLITION COSTS
(DISPOSAL AT FORT SMITH LANDFILL)

COST ITEM	AACM2 COST, $	ESTIMATED NESHAP COST, $			NESHAP Imminent Danger
		Abatement	Demolition	Total	
Pre-Demolition					
Pre-Demolition Asbestos Inspection	1,800	1,800	0	1,800	800
NESHAP Abatement					
Abatement	0	12,640	0	12,640	0
Worker Monitoring	0	1,200	0	1,200	700
Building Demolition					
Track-hoe (Excavator)	1,320	0	1,000	1,000	1,000
Labor	5,330	-	3,000	3,000	6,000
Hydrant water	103	10	15	25	80
Surfactant	740	0	0	0	0
Transportation and Disposal					
Roll-off Box Rental & Truck Operation	5,855	1,180	1,770	2,950	4,000
Landfill Disposal Charges	**1,725**	**800**	**700**	**1,500**	**1,600**
Supplies (poly sheeting, foam, glue, etc.)	3,500	500	0	500	1,200
Water Collection and Filtration					
Water Collection, Filtration, and Disposal	3,500	0	0	0	0
Summary Costs					
Total Cost	**$23,873**	$18,130	$6,485	**$24,615**	**$15,380**
Unit Cost, $/ft^2 of RACM (2,528 ft^2)	**$9.44**	$7.17	$2.56	**$9.73**	**$6.08**
Unit Cost, $/ft^2 (based on building footprint of 1,536 ft^2)	**$15.54**	$11.80	$4.22	**$16.02**	**$10.01**

8.10 Barrier Wall

The barrier wall constructed immediately adjacent to the back side of the transite building in combination with the AACM wetting process was very effective in minimizing asbestos migration. All three of the air samples on top of the barrier wall were non-detect for asbestos. Only one of the three dust samples had asbestos detected and that loading was minimal (2,740 s/cm^2).

8.11 Water Barrier

The process utilized the construction of the water containment process, which included cutting a kerf into the pavement, ringing the downgradient area with hay bales, tucking plastic into the kerf and sealing it with caulking, and applying some waterproofing to the asphalt surface immediately in front of the kerfed area, to effectively contain the water. During the initial testing before the demolition, the interstitial cracks in the pavement surface immediately in front of the plastic that was sealed into the kerf allowed some water to leak beneath the kerf and seep beneath the hay bales. This was quickly and effectively remedied by applying asbestos-free asphaltic roof sealant to the pavement forming an additional two-ft wide barrier on the interior of the containment bales to prevent the vertical permeation of the water. This process was about 99-percent effective in preventing seeps. Where one small seep remained, several absorbent tubes were placed to capture the leachate.

During the demolition, because there was little porous material in or on the building, a great deal of the applied water ran off into the collection sump, where it was captured and pumped into storage tanks. Later it was filtered and disposed into the city sanitary sewer.

There were numerous problems with the pump that was in the sump becoming clogged with debris and it required frequent cleaning. A vacuum truck might be significantly more trouble-free for larger job sites.

At the end of the demolition, all the barrier materials (hay and plastic) and the several absorbent tubes were disposed as asbestos-containing waste.

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.

9.1 Primary Objective

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

This hypothesis requires the evaluation of analytical data from two different laboratories, Bureau Veritas and EMSL. Although the results from all three labs were used in the descriptive statistics in the Results section, Amerisci performed no analyses on any of the background samples and therefore could not be included for the inferential statistics as there was no feasible comparison to be made between perimeter and background. Measurements are for total airborne asbestos (s/cm^3) from 18 AACM sampler locations and six BKGD sampler locations. A summary of the measurements for the two laboratories for the AACM process and BKGD sampling events is provided in Table 9-1 and the data are provided in Table 9-2.

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

Laboratory	Sampler Location	Sample Size	Censored Data		Detection Limits (s/cm^3)
			Percent	Number	
Bureau Veritas	AACM	18	39	7	0.00047, 0.00048, 0.00049
	BKGD	6	83	5	0.0048, 0.0085, 0.0086
EMSL	AACM	18	89	16	0.00046, 0.00047, 0.00048, 0.00049, 0.00050
	BKGD	6	100	6	0.00042, 0.00043

Table 9-2. TOTAL AIRBORNE ASBESTOS (TEM), s/cm^3

Sample Location	Bureau Veritas		EMSL	
	AACM	BKGD	AACM	BKGD
M01	<0.00047[1]	<0.0086	<0.00046	<0.00043
M02	0.00049	<0.0085	<0.00046	<0.00042
M03	<0.00049	<0.0086	<0.00046	<0.00043
M04	0.00049	<0.0086	0.00044	<0.00043
M05	<0.00049	0.3	<0.00046	<0.00043
M06	0.002	<0.00048	<0.00046	<0.00043
M07	<0.00048	All analyzed with the indirect method except M06.	<0.00048	All analyzed with the direct method.
M08	0.0038		<0.00048	
M09	<0.00049		<0.00047	
M10	<0.00049		<0.00048	
M11	0.0015		<0.00047	
M12	0.00048		<0.00048[2]	
M13	<0.00049		<0.00047	
M14	0.0015		<0.00048	
M15	0.0088		0.00157	
M16	0.00049		<0.00050	
M17	0.0024		<0.00048[2]	
M18	0.0024		<0.00049	

[1](<) denotes a censored value, where the minimum analytical sensitivity is the reported value.
[2]Two measurements were taken, both are censored the lowest analytical sensitivity is reported.

Due to the fact the censoring in the AACM and BKGD demolition data sets for both laboratories is above 39 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 data are displayed in Table 9-3. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

Table 9-3. AIRBORNE ASBESTOS (TEM) KAPLAN-MEIER Summary Statistics, s/cm^3

Laboratory	Group	Analytic Method	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
Bureau Veritas	AACM	Direct	18	7	0.0005	0.0015	0.0021
	BKGD	Indirect[2]	6	5	NA	0.3000	NA
EMSL	AACM	Direct	18	16	NA	0.0005	0.0003
	BKGD	Direct	6	6	NA	NA	NA

[1] The Kaplan-Meier method does not provide an estimation of the median when censoring is greater than 50%.
[2]All samples were analyzed using the indirect method with the exception of M06.

Due to the discrepancies between the laboratory measurements, the primary objective was evaluated by making AACM versus BKGD comparisons separately for each laboratory.

9.1.1 Laboratory: Bureau Veritas

The analytical methods used to analyze the AACM and BKGD samples were different. The AACM samples were analyzed using the direct method and all but one of the BKGD samples were analyzed using the indirect method. Since there is only valid BKGD measurement that can be used for an AACM versus BKGD comparison, a 95%- confidence interval was constructed for the AACM data using Kaplan-Meier method. The 95%- confidence for the AACM total asbestos concentration (s/cm^3) is [0.00057, 0.00251] with a standard error of 0.00049. The one Bureau Veritas BKGD sample (M06) analyzed with the direct method is below the minimum detection limit of 0.00048 s/cm^3. *Therefore, since the BKGD MDL was below the lower limit of the confidence interval (0.00057 s/cm^3), one would conclude it was significantly different than the mean Bureau Veritas AACM concentration of 0.0014 s/cm^3.*

9.1.2 Laboratory: EMSL

Since no inferential test for mean (median) differences could be conducted due to the high level of censoring (89% for AACM and 100% for BKGD), 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 for EMSL measurements are the same. The test provided a chi-square test statistic of, $\chi^2 = 0.7273$ with a p-value = 1. *Therefore one would conclude there was no difference in the probability of observing a censored value in the AACM and BKGD EMSL data sets.*

9.1.3 Laboratory Comparisons: Bureau Veritas versus EMSL versus Amerisci

Three of the AACM samples (M12, M14, and M16) were analyzed by three different laboratories, Bureau Veritas, EMSL and Amerisci. A summary of the measurements for the three laboratories for the three AACM samples event is provided in Table 9-4 and the data are provided in Table 9-5.

Table 9-4. SAMPLING EVENT SUMMARY FOR TOTAL AIRBORNE ASBESTOS FOR THREE AACM2 SAMPLES BY LABORATORY

Laboratory	Sample Size	Censored Data		Detection Limits (s/cm^3)
		Percent	Number	
Amerisci	3	0	0	NA
Bureau Veritas	3	0	0	NA
EMSL	3	100	3	0.00048, 0.00049, 0.00050

Table 9-5. TOTAL AIRBORNE ASBESTOS (TEM) FOR THREE AACM2 SAMPLES BY LABORATORY, s/cm^3

Sample Location	Amerisci	Bureau Veritas	EMSL
M012	0.00451	0.00048	<0.00048[2]
M014	0.00530	0.0015	<0.00048
M016	0.01157	0.00049	<0.00050

[1](<) denotes a censored value, where the minimum analytical sensitivity is the reported value.
[2]Two measurements were taken, both are censored the lowest analytical sensitivity is reported.

The descriptive statistics for Amerisci and Bureau Veritas are proved in Table 9-6 (EMSL samples were all censored so no descriptive statistics could be estimated). A *t*-test for mean differences was conducted for Amerisci versus Bureau Veritas provided a test statistic of 2.7905 with a *p*-value = 0.1028. *Since no comparisons were planned for samples of size three, the nominal significance level of 0.05 was increased for this comparison. Therefore, one would conclude the difference in the Amerisci and Bureau Veritas means, 0.00631 s/cm^3, was statistically significant at the 0.1028 level, but would not have been significant if the 0.05 level had been used.*

Table 9-6. AIRBORNE ASBESTOS (TEM) SUMMARY STATISTICS FOR THREE AACM2 SAMPLES BY LABORATORY, s/cm^3

Laboratory	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
Amerisci	3	0	0.00530	0.00713	0.00387
Bureau Veritas	3	0	0.00049	0.00082	0.00059
EMSL	3	3	NA	NA	NA

9.2 Secondary Objectives

9.2.1 Air

Null hypothesis: The airborne total fibers (PCM) from the demolition of the transite building by the AACM process were equivalent to the airborne total fibers (PCM) from BKGD.

Measurements are for total asbestos (fiber/cm^3) from 18 AACM sampler locations and six BKGD sampler locations. A summary of the measurements for the AACM process and BKGD sampling events is provided in Table 9-7.

Table 9-7. SAMPLING EVENT SUMMARY FOR TOTAL AIRBORNE FIBERS

Group	Sample Size	Censored Data		Detection Limits (fibers/cm^3)
		Percent	Number	
AACM	18	94	17	0.001
BKGD	6	100	6	0.0004

Due to the high level of censoring, 94% for AACM and 100% for BKGD, no inferential analyses could be conducted or descriptive statistics estimated. *Based on the empirical data, one would conclude there was no evidence to suggest the total airborne fibers from the demolition of the transite building by the AACM process are different from the total airborne (PCM) from BKGD.*

9.2.2 Dust

Null hypothesis: The asbestos concentrations in settled dust from the demolition of the transite building by the AACM were equivalent to the asbestos concentrations in settled dust from BKGD.

Measurements are for asbestos in settled dust, s/cm^2, from 18 AACM sampler locations and six BKGD sampler locations. A summary of the measurements for the AACM process and BKGD sampling events is provided in Table 9-8 and the data are provided in Table 9-9.

Table 9-8. SAMPLING EVENT SUMMARY FOR ASBESTOS IN SETTLED DUST

Group	Sample Size	Censored Data		Detection Limits (s/cm^2)
		Percent	Number	
AACM	18	28	5	211, 234, 244
BKGD	6	67	4	105, 211, 234

Table 9-9. ASBESTOS IN SETTLED DUST, s/cm^2

Sample Location	AACM	BKGD
M01	<211[1]	<211
M02	211	<105
M03	<234	<234
M04	211	<234
M05	<211	240
M06	<211	<211
M07	3,980	
M08	1,170	
M09	3,050	
M10	234	
M11	469	
M12	937	
M13	2,810	
M14	703	
M15	383	
M16	<244	
M17	234	
M18	234	

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

Due to the fact the censoring in the AACM and BKGD demolition data sets are 28 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 are displayed in Table 9-10 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 9-10. ASBESTOS IN SETTLED DUST KAPLAN-MEIER SUMMARY STATISTICS, s/cm^3

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
AACM	18	5	234	871	1176
BKGD	6	4	NA	335	394

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

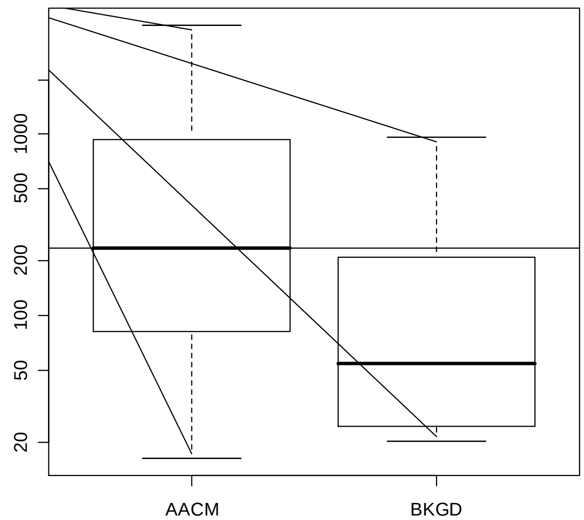

Figure 9-1. Box plots of total asbestos (s/cm^2) in settled dust for AACM and BKGD.
(The horizontal line is drawn at the highest analytical sensitivity)

The Peto-Prentice test for censored data was employed to test for differences in the asbestos concentration distributions between the AACM process and BKGD. The Peto-Prentice test provided a chi-square test statistic of, $\chi^2 = 2.2$ with 1 degree of freedom and a *p*-value = 0.14. *Based on this test, one would fail to reject the null hypothesis of no difference in the asbestos concentrations in the settled dust (TEM s/cm^2) for AACM and BKGD. Although due to the high level of censoring, an inferential test for AACM and BKGD mean differences could not be conducted, it appears the mean concentration of asbestos in the AACM settled dust (871 s/cm^2) was greater than BKGD (335 s/cm^2).*

9.2.3 Pavement

Null hypothesis: The asbestos concentrations on post-demolition pavement from the AACM demolition are equivalent to the BKGD asbestos concentrations on pavement.

Null hypothesis: The asbestos concentrations on pre-demolition pavement were equivalent to the asbestos concentrations on post-demolition clean-up pavement from the AACM demolition

This hypothesis requires the evaluation of data from two different AACM2 sampling events: pre-demolition of the building and post-demolition of the building. Measurements are for total asbestos concentration, s/cm^2, from eight AACM and four BKGD sampler locations. A summary of the two AACM2 sampling events and the single BKGD event is provided in Table 9-11 and the data are provided in Table 9-12.

Table 9-11. SAMPLING EVENT SUMMARY FOR PAVEMENT

Group	Event	Sample Size	Censored Data		Detection Limits (s/cm^2)
			Percent	Number	
AACM	Pre-Dem	8	25	2	863
	Post-Dem	8	87	7	432
BKGD	Pre-Dem	4	75	3	863

Table 9-12. ASBESTOS ON PAVEMENT, s/cm^2

Sample Location	Pre-Demolition	Post-Demolition	Background
M01	10,400	<432	<863
M02	10,300	<432	<863
M03	<863[1]	<432	938
M04	1,730	<432	<863
M05	<863	19,900	
M06	1,880	<432	
M07	6,280	<432	
M08	1,880	<432	

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

Due to the censoring, 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 are displayed in Table 9-13 and box plots are displayed in Figure 9-2. Although these estimates appear reasonable, care should be taken in their interpretation due to the large number of censored observations.

Table 9-13. ASBESTOS ON PAVEMENT KAPLAN-MEIER SUMMARY STATISTICS, s/cm^2

Group	Sample Size	Number Censored	Median[1]	Mean	Std. Dev.
PRE-DEM	8	2	1,880	4,491	4,032
POST-DEM	8	7	NA	19,900	NA
BKGD	4	3	NA	938	NA

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

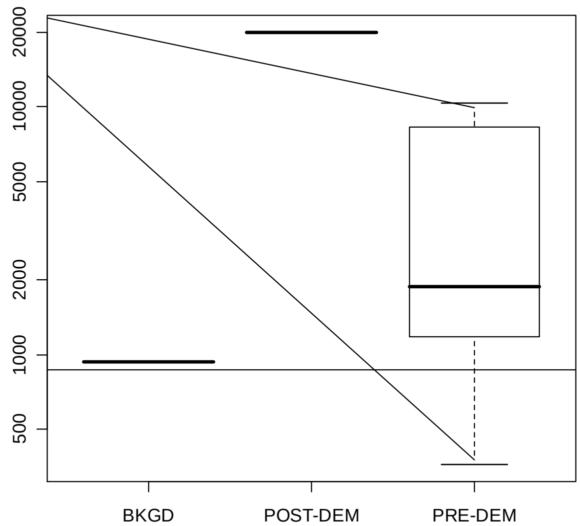

Figure 9-2. Box plots of asbestos (s/cm^2) on pavement pre- and post-demolition and BKGD.
(The horizontal line is drawn at the highest analytical sensitivity)

Due to the high level of censoring, 87% for post-demolition and 75% for BKGD, no inferential analyses could be conducted or descriptive statistics estimated. *Based on the empirical data, one would conclude there was no evidence to suggest the asbestos concentrations on pavement for pre-demolition and BKGD are different.*

Since no inferential test for mean (median) differences could be conducted due to the high level of censoring, 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 pre- and post- measurements are the same. The test provided a chi-square test statistic of, $\chi^2 = 6.3492$ with a *p*-value = 0.03848. *Therefore one would conclude there was a difference in the probability of observing a censored value in the pre- and post-demolition data sets; i.e., one is more likely to observe a censored value in the post-demolition data.*

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 effort (AACM2) is the second of the AACM research efforts, each targeting specific asbestos and building/site configurations. AACM2 evaluated the use of the AACM process on a transite-covered building that was in danger of imminent collapse at the Fort Chaffee Redevelopment Authority near Fort Smith, AR. Separate reports have been issued for AACM1 and AACM3.

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 transite building (AACM2) at Fort Chaffee Redevelopment Authority:

Primary Objective:

- The airborne asbestos concentrations measured by transmission electron microscopy (TEM) during the AACM2 demolition processes were orders of magnitude below any EPA existing health or performance criterion. Almost all of the airborne asbestos (TEM) concentrations were near or below the limit of detection, which was 0.0015 s/cm^3 (or 2.99 times the analytical sensitivity of 0.0005 s/cm^3). Only five samples exceeded the limit of detection, with the highest total asbestos concentration being 0.0052 s/cm^3.

- The statistical analyses were restricted by differences in results from different analytical laboratories and by the fact that some laboratory samples were overloaded and required indirect analysis, which are not directly comparable with direct analysis results. First, the statistical analyses concluded that there were differences in results from the different laboratories. Using one lab's results, the inferential statistics indicated *since the background mean detection limit was below the lower limit of the confidence interval (0.00057 s/cm^3), one would conclude it was significantly different than the mean perimeter concentration of 0.0014 s/cm^3*. Using the second lab's results, however, the statistical conclusions were that *one would conclude there was no difference in the probability of observing a censored (non-detect) value in the perimeter and background data sets*. Overall, the statistical analyses were inconclusive in determining whether there was a difference between the perimeter and background airborne asbestos concentrations.

Secondary Objectives

AIR

- No visible emissions were observed during the AACM2 demolition.

- Virtually all the perimeter, top of wall, and background air samples were non-detect for fibers as measured by Phase Contrast Microscopy (PCM). There was one single fiber detected in one sample (0.001 f/cm^3). This is likely because there was little fibrous material in the transite building to begin with and because the amended water was effective at suppressing releases.

DUST

- Many of the perimeter samples and some of the background samples contained asbestos in the dust. The maximum dust loading was 3,980 s/cm^2 in a perimeter sample and 958 s/cm^2 in a background sample. Although *the statistical analyses indicated one would fail to reject the null hypothesis of no difference in the asbestos concentrations in the settled dust (TEM s/cm^2) for perimeter and background*, the empirical data appear to indicate a difference in the asbestos concentrations. Also, *due to the high level of censoring(non-detects), an inferential test for AACM and BKGD mean differences could not be conducted, it appears the Kaplan-Meier mean concentration of asbestos in the AACM2 perimeter settled dust was greater than background.*

WORKERS

- Five of the seven worker breathing zone samples were non-detect for total asbestos at the 0.001 s/cm^3 analytical sensitivity level. None of the worker samples showed detectable PCME asbestos structures during the demolitions. The two worker samples that showed detectable asbestos had breathing zone asbestos concentrations of 0.006 and 0.002 s/cm^3 respectively.

- Only one of the six workers had PCM fibers observed on their breathing zone filters, and that concentration was 0.003 f/cm^3. Time-weighted averages, based upon the PCM fiber counts above, were therefore well below the OSHA Personal Exposure Limit (PEL) of 0.1 f/cm^3.

PAVEMENT

- The site assessment survey data showed very high pavement dust asbestos loadings (2,700,000 s/cm^2 max), highlighting the problem of erosion of weathered transite and subsequent contamination of adjacent surfaces. The AACM2 effectively reduced the pavement dust levels as seven of eight post-demolition pavement samples were non-detect for asbestos. *The statistical analysis indicated that one would conclude there was a difference in the probability of observing a censored (non-detect) value in the pre- and* *post-demolition data sets; i.e., one is more likely to observe a censored value in the post-demolition data.*

WATER

- As has been seen in each of the AACM demolitions, the amended water captured significant amounts of asbestos. The mean asbestos concentration in the captured AACM water was about 40 billion asbestos structures (of all sizes) per liter. This water was all captured, filtered, and disposed to the sanitary sewer.

TIME

- Even with delays caused by the research nature of the project and the extreme heat hampering worker effectiveness, it required two days to demolish the transite building by the AACM protocol; it is estimated that three days would have been required for the NESHAP protocol if abatement had been done.

COST

- Overall, the use of AACM2 at the transite building and disposal of the waste at the Fort Smith Landfill was about equal to what the demolition cost would have been by the NESHAP. The total cost for the AACM2 process was $23,873 compared to $24,615 for the NESHAP (with abatement). If the building would have been demolished by the NESHAP Imminent Danger provision, it would have cost an estimated $15,380.

CONTAINMENT

The barrier wall constructed immediately adjacent to the back side of the transite building to simulate closely adjacent buildings was very effective in minimizing asbestos migration. All three of the air samples on top of the barrier wall were non-detect for asbestos. Only one of the three dust samples had asbestos detected and that loading was minimal (2,740 s/cm^2).

SECTION 11 Lessons Learned

- The use of hay bales, covered with plastic tucked and sealed into kerfs cut into the pavement and supplemented by the use of roof sealant on the immediate pavement surface next to the barrier, provided an excellent containment of amended water during the demolition.

- The interstitial cracks in the pavement will form conduits for the water in back of the containment barrier to seep below the kerf that was cut into the pavement and leak beyond the barrier. This was easily and effectively remedied by applying a two-ft wide surface coating of roof sealant on the pavement surface immediately adjacent to the containment barrier.

- Lining the roll-offs outside of containment was far faster and more efficient that lining them while inside the containment zone.

- On hot days, tag-team the asbestos workers to prevent heat stress in the PPE.

- If possible, stringy items such as Velcro rolls should be removed before demolition as they severely hamper track-hoe loading efficiency.

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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
7/29/2007	5:30	1	33.1	75.6	82.6	29.35	0
7/29/2007	5:45	0.8	78.7	74.8	85	29.35	0
7/29/2007	6:00	0.4	105.5	75.3	83.4	29.35	0
7/29/2007	6:15	0.6	34.6	75.4	82.8	29.36	0
7/29/2007	6:30	1.1	17.1	75	85.4	29.37	0
7/29/2007	6:45	0.9	37.8	75.4	83.3	29.37	0
7/29/2007	7:00	1.7	24.2	75.3	85.8	29.37	0
7/29/2007	7:15	1.3	48.3	75.6	85.9	29.37	0
7/29/2007	7:30	0.8	47.1	76.5	84.2	29.37	0
7/29/2007	7:45	1.1	84.6	77	82.6	29.38	0
7/29/2007	8:00	0.9	62.2	77.4	81.7	29.38	0
7/29/2007	8:15	0.9	51.3	77.8	80.9	29.38	0
7/29/2007	8:30	1.1	51.9	78.4	79.3	29.39	0
7/29/2007	8:45	1.6	40.3	79.2	77.3	29.39	0
7/29/2007	9:00	2.3	81.3	80.5	74.4	29.39	0
7/29/2007	9:15	2.3	86.2	81.7	71	29.39	0
7/29/2007	9:30	2	52.4	82.4	70.3	29.39	0
7/29/2007	9:45	2.5	25.8	83.4	68.3	29.39	0
7/29/2007	10:00	2.4	45.8	84.7	65	29.39	0
7/29/2007	10:15	2	102.2	86.5	61.2	29.39	0
7/29/2007	10:30	2.6	80.5	87	59.4	29.39	0
7/29/2007	10:45	2.3	57.7	88.6	56.6	29.39	0
7/29/2007	11:00	2.4	137.4	88.1	56.5	29.39	0
7/29/2007	11:15	2.2	7.9	91.1	54.3	29.39	0
7/29/2007	11:30	1.9	34.6	91.6	53.4	29.39	0
7/29/2007	11:45	2.8	16.1	90.8	54.4	29.39	0
7/29/2007	12:00	3.6	4.7	90	56.2	29.39	0
7/29/2007	12:15	2.4	75.6	90.8	54.1	29.39	0
7/29/2007	12:30	3.6	10.7	91.4	54.2	29.39	0
7/29/2007	12:45	4	17.4	92.6	51.6	29.38	0
7/29/2007	13:00	4.4	332.6	91.4	52.1	29.39	0
7/29/2007	13:15	4.9	341.6	91.6	52.5	29.38	0
7/29/2007	13:30	3.8	7.5	91.4	53	29.38	0
7/29/2007	13:45	3.3	49.4	91.9	53.3	29.37	0
7/29/2007	14:00	2.7	54.3	92.7	51.7	29.36	0
7/29/2007	14:15	3.1	346.9	94.4	49.7	29.35	0
7/29/2007	14:30	3.2	55.4	94.8	49.3	29.34	0
7/29/2007	14:45	3.3	35.7	95	49.1	29.34	0
7/29/2007	15:00	3.3	299.6	94.6	49.4	29.33	0
7/29/2007	15:15	4	344.4	94.7	49.6	29.32	0

7/29/2007	15:30	3.1	20.4	95.8	47.4	29.32	0
7/29/2007	15:45	3.6	4.9	96.8	46.1	29.32	0
7/29/2007	16:00	2.9	60.3	97.9	44.1	29.31	0
7/29/2007	16:15	3.6	28.6	97.7	45.2	29.3	0
7/29/2007	16:30	4.8	3.3	94.2	49.9	29.32	0
7/29/2007	16:45	8.7	357.7	91.8	58	29.33	0
7/29/2007	17:00	6.4	344.5	82.6	76.7	29.34	0
7/29/2007	17:15	4.4	44.1	82.6	76	29.34	0
7/29/2007	17:30	4	58.3	81.7	75.2	29.33	0
7/29/2007	17:45	3.1	63.2	82	72.3	29.33	0
7/29/2007	18:00	2.9	36.1	82.1	74.2	29.33	0
7/29/2007	18:15	2.3	57	81.5	74	29.33	0
7/29/2007	18:30	1.4	70.2	81.7	72.7	29.33	0
7/29/2007	18:45	2	27.1	81.8	71.9	29.34	0
7/29/2007	19:00	3.5	15.4	80.5	78	29.34	0
7/29/2007	19:15	1.9	37	79.7	79	29.35	0
7/29/2007	19:30	1.3	46.7	80.6	73.8	29.36	0
7/29/2007	19:45	1.9	8	81	73.4	29.36	0
7/29/2007	20:00	2.2	20.1	80.2	77.6	29.36	0
7/29/2007	20:15	1.5	22.1	79.4	80.4	29.37	0
7/29/2007	20:30	0.8	41.1	79.7	78.5	29.37	0
MEANS		2.6	78.5	85.2	66.5	29.4	0
MAX		8.7	-	97.9	85.9	29.4	0

Table 13-2. LABORATORY DATA: SAMPLE KEY

Label Category	Label ID	ID Description	Relevant Media
MEDIA	AIR	Air	NA
	WATER	Water	NA
	PAVE	Pavement	NA
	SDUST	Settled Dust	NA
	WORK	Worker Air	NA
LOCATION/ BUILDING	TB	Transite Building	ALL
	BG	Background	ALL
	SAA	Site Assessment Sample	ALL
COPC	ASB	Asbestos	ALL
	PB	Lead	Worker Air
PUMP FLOW RATE	4L	Target Air Flow Rate: 4 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	Pavement
	POST	Post- (Building) Demolition	Pavement
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 IN PERIMETER AIR SAMPLES

Sample Number	Lab	Sample Volume, Liters	Grid Openings Analyzed[1,2]	Total Structures Counted	Asbestos (TEM)[2], s/cm[3]			Total Fibers (PCM), fibers/cm[3]	Notes
					Total	Average Concentration[3]	PCME		
Perimeter Samples									
TB-Air-M01-4L	Bureau Veritas	3171	26	0	<0.00047	<0.00047	<0.00047	---	
	EMSL		22	0	<0.00046		<0.00046	<0.001	
TB-Air-M02-4L	Bureau Veritas	3151	25	1	0.00049	<0.00049	<0.00049	---	
	EMSL		22	0	<0.00046		<0.00046	<0.001	
TB-Air-M03-4L	Bureau Veritas	3182	25	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		22	0	<0.00046		<0.00046	<0.001	
TB-Air-M04-4L	Bureau Veritas	3047	26	1	0.00049	0.00047	<0.00049	---	
	EMSL		24	1	0.00044		<0.00044	<0.001	
TB-Air-M05-4L	Bureau Veritas	3022	26	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		23	0	<0.00046		<0.00046	<0.001	
TB-Air-M06-4L	Bureau Veritas	3054	26	4	0.00200	0.00100	<0.00049	---	
	EMSL		23	0	<0.00046		<0.00046	<0.001	
TB-Air-M07-4L	Bureau Veritas	3018	27	0	<0.00048	<0.00048	<0.00048	---	
	EMSL		22	0	<0.00048		<0.00048	<0.001	
TB-Air-M08-4L	Bureau Veritas	3017	27	8	0.00380	0.00190	<0.00048	---	
	EMSL		22	0	<0.00048		<0.00048	<0.001	
TB-Air-M09-4L	Bureau Veritas	3034	26	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		22	0	<0.00047		<0.00047	<0.001	
TB-Air-M10-4L	Bureau Veritas	3028	26	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		22	0	<0.00048		<0.00048	<0.001	
TB-Air-M11-4L	Bureau Veritas	3074	26	3	0.0015	0.00075	<0.00049	---	
	EMSL		22	0	<0.00047		<0.00047	<0.001	
TB-Air-M12-4L	Bureau Veritas[4]	6076	27	1	0.00048	0.00166	0.00048	---	
	Amerisci	3021	30	10	0.00451		<0.00045	---	
	EMSL		22	0	<0.00048		<0.00048	<0.001	
TB-Air-M12-4L-DUP	Bureau Veritas	2986	29	7	0.0031	0.00155	<0.00045	---	
	EMSL		22	0	<0.00049		<0.00049	<0.001	
TB-Air-M13-4L	Bureau Veritas	2962	27	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		23	0	<0.00047		<0.00047	<0.001	
TB-Air-M14-4L	Bureau Veritas[4]	6165	26	3	0.00150	0.00227	<0.00049	---	
	Amerisci	3066	30	12	0.00530		<0.00044	---	
	EMSL		22	0	<0.00048		<0.00048	<0.001	

Sample Number	Lab	Sample Volume, Liters	Grid Openings Analyzed[1,2]	Total Structures Counted	Asbestos (TEM)[2], s/cm³ Total	Average Concentration[3]	PCME	Total Fibers (PCM), fibers/cm³	Notes
TB-Air-M15-4L	Bureau Veritas	3066	26	18	0.00880	0.00519	<0.00049	---	
	EMSL		20	3	0.00157		<0.00052	<0.001	
TB-Air-M16-4L	Bureau Veritas[4]	6117	26	1	0.00049	0.00402	<0.00049	---	
	Amerisci	3083	30	26	0.01157		<.00045	---	
	EMSL		21	0	<0.00050		<0.00050	0.001	
TB-Air-M17-4L	Bureau Veritas	3058	26	5	0.00240	0.00120	<0.00049	---	
	EMSL		21	0	<0.0005		<0.0005	<0.001	
TB-Air-M17-4L - DUP	Bureau Veritas	3030	26	5	0.00250	0.00125	<0.00049	---	
	EMSL		22	0	<0.00048		<0.00048	<0.001	
TB-Air-M18-4L	Bureau Veritas	2987	27	5	0.00240	0.00120	0.00048	---	
	EMSL		22	0	<0.00049		<0.00049	<0.001	
Barrier Wall Samples									
TB-Air-M19-4L	Bureau Veritas	3179	25	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		21	0	<0.00048		<0.00048	<0.001	
TB-Air-M20-4L	Bureau Veritas	3192	25	0	<0.00049	<0.00049	<0.00049	---	
	EMSL		21	1	0.00048		<0.00048	<0.001	
TB-Air-M21-4L	Bureau Veritas	3262	25	0	<0.00048	<0.00049	<0.00048	---	
	EMSL		20	0	<0.00049		<0.00049	<0.001	20-25% overloaded
TB-Air-BL	EMSL	0	10	0	<10 s/mm²	---	<10 s/mm²	---	
TB-Air-BL	EMSL	0	10	0	<10 s/mm²	---	<10 s/mm²	---	
Background Samples									
BG-AIR-M01-8L	Bureau Veritas	6265	20	0	<0.00860	<0.00860	<0.00860	---	Indirect Analysis
	EMSL		12	0	<0.00043		<0.00043	<0.0004	25% overloaded, Direct Analysis
BG-AIR-M02-8L	Bureau Veritas	6345	20	0	<0.00850	<0.00850	<0.00850	---	Indirect Analysis
	EMSL		12	0	<0.00042		<0.00042	<0.0004	25% overloaded, Direct Analysis
BG-AIR-M03-8L	Bureau Veritas	6241	20	0	<0.0086	<0.00860	<0.00860	---	Indirect Analysis
	EMSL		12	0	<0.00043		<0.00043	<0.0004	25% overloaded, Direct Analysis
BG-AIR-M04-8L	Bureau Veritas	6274	20	0	<0.00860	<0.00860	<0.00860	---	Indirect Analysis
	EMSL		12	0	<0.00043		<0.00043	<0.0004	25% overloaded, Direct Analysis

Sample Number	Lab	Sample Volume, Liters	Grid Openings Analyzed[1,2]	Total Structures Counted	Asbestos (TEM)[2], s/cm[3]			Total Fibers (PCM), fibers/cm[3]	Notes
					Total	Average Concentration[3]	PCME		
BG-AIR-M05-8L	Bureau Veritas	6262	20	35	0.30000	0.15000	<0.00860	---	Direct Analysis
	EMSL		12	0	<0.00043		<0.00043	<0.0004	25% overloaded, Direct Analysis
BG-AIR-M06-8L	Bureau Veritas	6270	13	0	<0.00048	<0.00048	<0.00048	---	Direct Analysis
	EMSL		12	0	<0.00043		<0.00043	<0.0004	Direct Analysis
Site Assessment Samples									
SAA-001	EMSL	2149	32	0	<0.00047	---	---	0.002	
SAA-002	EMSL	2097	32	0	<0.00048	---	---	0.002	
SAA-003	EMSL	0	32	0	BLANK	---	---	BLANK	
SAA-004	EMSL	2126	32	0	<0.00047	---	---	<0.001	
SAA-005	EMSL	2083	32	0	<0.00048	---	---	0.002	

[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.
[3] Average concentrations among labs used zeros for non-detects, but the final average value could not be lower than the analytical sensitivity.
[4]No filter remained for analysis. BV prepared new grids for analysis using eight-liter filter samples that were previously carbon coated by EMSL.

Table 13-4. PAVEMENT SAMPLES

Sample Number[1]	Aliquot Deposited on Filter, mL[1]	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM)[2], s/cm[2]			
			Chrysotile	Amphibole	Chrysotile[2]	Amphibole[2]	Total[2]	PCME[2]
AACM2 Building – Pre-Demolition Pavement Samples[3,4]								
TB-PAVE PRE-01-2L	10	27	13	0	10,400	<799	10,400	<799
TB-PAVE PRE-02-2L	5	46	11	0	10,300	<938	10,300	<938
TB-PAVE PRE-03-2L	25	10	0	0	<863	<863	<863	<863
TB-PAVE PRE-04-2L	25	10	2	0	1,730	<863	1,730	<863
TB-PAVE PRE-05-2L	25	10	0	0	<863	<863	<863	<863
TB-PAVE PRE-06-2L	SAMPLE VOIDED –Replaced with TB-PAVE PRE-15-2L							
TB-PAVE PRE-15-2L	10	23	2	0	1,880	<938	1,880	<938
TB-PAVE PRE-07-2L	10	11	8	0	6,280	<785	6,280	<785
TB-PAVE PRE-08-2L	50	23	2	0	1,880	<938	1,880	<938
TB-PAVE PRE-09-2L-BL	25	10	0	0	BLANK	BLANK	BLANK	BLANK
Background								
BG-PAVE-10-2L	25	10	0	0	<863	<863	<863	<863
BG-PAVE-11-2L	25	33	0	0	<863	<863	<863	<863
BG-PAVE-12-2L	10	23	1	0	938	<938	938	<938
BG-PAVE-13-2L	25	10	0	0	<863	<863	<863	<863
BG-PAVE-14-2L-BL	50	10	0	0	BLANK	BLANK	BLANK	BLANK
AACM2 Building – Post-Demolition Pavement Samples								
TB-PAVEPOST-01-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-02-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-03-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-04-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-05-2L	25	10	23	0	19,900	<863	19,900	<863
TB-PAVEPOST-06-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-07-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-08-2L	50	10	0	0	<432	<432	<432	<432
TB-PAVEPOST-09-2L	50	10	0	0	BLANK	BLANK	BLANK	BLANK
TB-PAVEPOST-09-BL	50	10	0	0	BLANK	BLANK	BLANK	BLANK
Site Assessment Samples (AHERA Counting Rules)								
SAP-001	25	10	0	0	BLANK	BLANK	BLANK	BLANK
SAP-002	5	2	100	0	2,200,000	<22,000	2,200,000	N/A*

Sample Number[1]	Aliquot Deposited on Filter, mL[1]	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM)[2], s/cm[2]			
			Chrysotile	Amphibole	Chrysotile[2]	Amphibole[2]	Total[2]	PCME[2]
SAP-003	1	8	100	0	2,700,000	<27,000	2,700,000	N/A*
SAP-004	10	72	102	0	30,000	<300	30,000	N/A*
SAP-005	10	87	2	0	500	<250	500	<250

[1]Grid opening size = 0.0060 mm^2; effective filter area = 1295 mm^2; [2] Sample Area = 100 cm^2 ; [3] Sample Total Volume = 100 ml
*Samples were analyzed utilizing AHERA counting rules

Table 13-5. WATER ANALYSES

Sample Number	Aliquot Deposited on Filter, mL[1]	Grid Openings Analyzed[2]	Asbestos Structures Counted[3]		Asbestos Concentration, million s/L	
			>10µ	Total	>10µ	Total
Hydrant Water						
TB-HW-01	25	110	0	9	<0.04	0.35
TB-HW-02	50	56	0	0	<0.04	<0.04
TB-HW-02-DUP	50	54	0	0	<0.04	<0.04
TB-HW-BL	100	10	0	0	<0.11	<0.11
Amended Water						
TB-AW-01	10	282	0	2	<0.04	0.08
TB-AW-02	25	112	0	0	<0.04	<0.04
TB-AW-DUP	25	110	0	0	<0.04	<0.04
Surface Water						
TB-AWSURF-01	0.5	5	5	105	215	4,500
TB-AWSURF-02	1	43	1	103	2.5	260
TB-AWSURF-03	0.01	9	3	103	3,500	120,000
TB-AWSURF-DUP	0.01	8	2	100	2,600	130,000
TB-AWSURF-BL	100	14	0	0	<0.04	<0.04
Site Assessment Hydrant Samples						
SAW001-A	10	220	0	0	<0.05	<0.05
SAW001-B	Not analyzed					
SAW002	Not analyzed					

[1]Aliquot deposited on filter based on observed particulate loading in water sample
[2]Grid opening size = 0.012 mm^2; EFA equals 1295 mm^2.
[3] Modification to method 100.2, all structures ≥ 0.5 were counted

Table 13-6. ASBESTOS IN SETTLED DUST

Sample Number	Aliquot Deposited on Filter, mL[1,2]	Grid Openings Analyzed[3]	Structures Counted			Total Asbestos[4], s/cm²	PCME
			Chrysotile	Amphibole	Total		
Background Samples							
BG-DUST-M01	25	10	1	0	1	211	<211
BG-DUST-M02	50	10	0	0	0	<105	<105
BG-DUST-M03	25	9	0	0	0	<234	<234
BG-DUST-M04	25	9	0	0	0	<234	<234
BG-DUST-M05	10	22	4	0	4	958	240
BG-DUST-M06	50	5	0	0	0	<211	<211
Perimeter Samples							
TB-DUST-M01	50	5	0	0	0	<211	<211
TB-DUST-M02	50	5	1	0	1	211	<211
TB-DUST-M03	25	9	0	0	0	<234	<234
TB-DUST-M04	25	5	1	0	1	211	<211
TB-DUST-M05	50	5	0	0	0	<211	<211
TB-DUST-M06	50	5	0	0	0	<211	<211
TB-DUST-M07	25	9	17	0	17	3,980	<234
TB-DUST-M08	25	9	5	0	5	1,170	<234
TB-DUST-M09	25	9	13	0	13	3,050	234
TB-DUST-M10	25	9	1	0	1	234	<234
TB-DUST-M10-DUP	25	9	3	0	3	703	<234
TB-DUST-M11	25	9	2	0	2	469	<234
TB-DUST-M12	25	9	4	0	4	937	<234
TB-DUST-M13	25	9	12	0	12	2,810	<234
TB-DUST-M14	25	9	3	0	3	703	<234
TB-DUST-M15	25	11	2	0	2	383	<192
TB-DUST-M16	50	5	0	0	0	<211	<211
TB-DUST-M17	25	9	1	0	1	234	<234
TB-DUST-M18	25	9	1	0	1	234	<234
TB-DUST-M18-DUP	25	9	0	0	0	<234	<234

Sample Number	Aliquot Deposited on Filter, mL[1,2]	Grid Openings Analyzed[3]	Structures Counted			Total Asbestos[4], s/cm^2	PCME
			Chrysotile	Amphibole	Total		
Top of Barrier Wall							
TB-DUST-M19	25	9	0	0	0	<234	<234
TB-DUST-M20	50	5	0	0	0	<211	<211
TB-DUST-M21	50	5	13	0	13	2,740	211
BG-DUST-BL	50	10	0	0	0	BLANK	
TB-DUST-BL	50	10	0	0	0	BLANK	
TB-DUST-BL-02	50	10	0	0	0	BLANK	

[1]Total rinsate volume equals 100ml.
[2]Aliquot deposited on filter based on observed particulate loading in rinsate sample.
[3]Grid opening size = 0.013 mm^2; effective filter area = 1295 mm^2.
[4]Area sampled = 100 cm^2.

Table 13-7. WORKER BREATHING ZONE ASBESTOS AND FIBER SAMPLES

Sample Number	Sample Volume, Liters	Grid Openings Analyzed[1]	Structures Counted		Asbestos (TEM)[2], s/cm^3				Total Fibers (PCM), f/cm^3
			Chrysotile	Amphibole	Chrysotile	Amphibole	Total	PCME	
TB-WORK-DEWAYNEJOHNSON-2L	1293	34	0	0	<0.00073	<0.00073	<0.00073	<0.00073	<0.002
TB-WORK-JOHNNIEPOSTOCK-2L	974	47	0	0	<0.00070	<0.00070	<0.00070	<0.00070	0.003
TB-WORK-GARYLEWIS-2L	1694	25	8	0	0.00606	<0.00076	0.00606	<0.00076	<0.002
TB-WORK-KEITHSAMPSON-2L	1702	25	0	0	<0.00075	<0.00075	<0.00075	<0.00075	<0.002
TB-WORK-KEITHSAMPSON-2L-DUP	1766	25	7	0	0.00509	<0.00073	0.00509	<0.00073	<0.002
TB-WORK-OSCARGRANERA-2L	1588	26	2	0	0.00155	<0.00078	0.00155	<0.00078	<0.002
TB-WORK-OSCARGRANERA-2L-DUP	1760	26	0	0	<0.00070	<0.00070	<0.00070	<0.00070	<0.002
TB-WORK-GILLORMOAYALA-2L	1567	26	0	0	<0.00078	<0.00078	<0.00078	<0.00078	<0.002
TB-WORK-FREDJONES-2L	837	36	0	0	<0.00107	<0.00107	<0.00107	<0.00107	<0.003
FIELD BLANK	0	10	0	0	<10	<10	<10	<10	
FIELD BLANK	0	10	0	0	<10	<10	<10	<10	

[1]Grid opening size = 0.0091 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.
[3]Field Blanks = <10 s/mm^2

Table 13-8. TCLP RESULTS FOR THE TRANSITE BUILDING

Sample Number	TEST	Method	Parameter	Concentration, mg/l
T-001	C-Metals by ICP	6010B	Arsenic	<0.080
	C-Metals by ICP	6010B	Barium	<1.0
	C-Metals by ICP	6010B	Cadmium	<0.040
	C-Metals by ICP	6010B	Chromium	<0.10
T-001	C-Metals by ICP	6010B	Lead	<0.10
	C-Metals by ICP	6010B	Selenium	<0.20
	C-Metals by ICP	6010B	Silver	<0.10
	C-Metals by ICP	7470A	Mercury	<0.0020

Table 13-9. WORKER BREATHING ZONE LEAD SAMPLES

Sample Number	TEST	Method	Parameter	Concentration, $\mu g/m^3$
TB-WORK-DEWAYNEJOHNSON-2L	C-Metals by ICP	7300 Modified	Lead	<0.53
TB-WORK-JOHNNIEPOSTOCK-2L	C-Metals by ICP	7300 Modified	Lead	<0.56
TB-WORK-GARYLEWIS-2L	C-Metals by ICP	7300 Modified	Lead	<0.28
TB-WORK-KEITHSAMPSON-2L	C-Metals by ICP	7300 Modified	Lead	<0.28
TB-WORK-OSCAR GRANERA-2L	C-Metals by ICP	7300 Modified	Lead	<0.28
TB-WORK-FREDJONES-2L	C-Metals by ICP	7300 Modified	Lead	<0.62
TB-WORK-GILLORMOAYALA-2L[1]	C-Metals by ICP	7300 Modified	Lead	Void
BLANK	C-Metals by ICP	7300 Modified	Lead	<0.05

[1] Sample was dropped into dirty water.

Table 13-10. BULK SAMPLE RESULTS FOR TRANSITE BUILDING

Sample Number	Location of sample	Appearance	% Fibrous	% Non-Fibrous	% Asbestos and Type
1A-Cementitious Siding	Exterior of Building	Gray Non-fibrous	0	70% Non Fibrous (other)	30% Chrysotile
1A- Felt	Exterior of Building	Brown Fibrous	90% Cellulose	10% Non-Fibrous (other)	None Detected
1B-Cementitious Siding	Exterior of Building				Stop Positive (Not Analyzed)
1B-Felt	Exterior of Building	Brown Fibrous	90% Cellulose	10% Non-Fibrous (other)	None Detected
1C-Cementitious Siding	Exterior of Building				Stop Positive (Not Analyzed)
1C-Felt	Exterior of Building	Brown Fibrous	90% Cellulose	10% Non-Fibrous (other)	None Detected
2A	Over Exterior Windows and Doors	Gray Non-Fibrous		70% Non-Fibrous (other)	30% Chrysotile
2B	Over Exterior Windows and Doors				Stop Positive (Not Analyzed)
2C	Over Exterior Windows and Doors				Stop Positive (Not Analyzed)
3A	Exterior Facia	White/Black /Green Fibrous	50% Cellulose	50% Non-Fibrous (other)	None Detected
3B	Exterior Facia	White/Black /Green Fibrous	50% Cellulose	50% Non-Fibrous (other)	None Detected
3C	Exterior Facia	White/Black /Green Fibrous	50% Cellulose	50% Non-Fibrous (other)	None Detected
4A	Bathroom	Brown/ White Fibrous	20% Cellulose	80% Non-Fibrous (other)	None Detected
4B	Bathroom	Brown/ White Fibrous	10% Cellulose	90% Non-Fibrous (other)	None Detected
4C	Bathroom	Brown/ White Fibrous	15% Cellulose	85% Non-Fibrous (other)	None Detected
5A	Exterior Windows	Brown/Gray Non-Fibrous		100% Non-Fibrous (other)	None Detected

Sample Number	Location of sample	Appearance	% Fibrous	% Non-Fibrous	% Asbestos and Type
5B	Exterior Windows	Brown/Gray Non-Fibrous		100% Non-Fibrous (other)	None Detected
5C	Exterior Windows	Brown/Gray Non-Fibrous		100% Non-Fibrous (other)	None Detected
6A	Roof	Brown/Black/Silver Non-Fibrous	30% Cellulose 10% Glass	60% Non-Fibrous (other)	None Detected
6B	Roof	Brown/Black/Silver Non-Fibrous	30% Cellulose	70% Non-Fibrous (other)	None Detected
6C	Roof	Brown/Black/Silver Non-Fibrous	30% Cellulose	70% Non-Fibrous (other)	None Detected
7A	Landing	Black/Rust Fibrous	80% Cellulose	20% Non-Fibrous (other)	None Detected
7B	Landing	Black/Rust Fibrous	80% Cellulose	20% Non-Fibrous (other)	None Detected
7C	Landing	Black/Rust Fibrous	80% Cellulose	20% Non-Fibrous (other)	None Detected