FINAL
REMEDIAL INVESTIGATION WORK PLAN
OUTDOOR AMBIENT AIR STUDY

Operable Unit Number 7
of the Libby Asbestos Superfund Site

October 14, 2009

Prepared for:

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
Remediation Division
P.O. Box 200901
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Contract Number 407026
Contract Task Order Number 44

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LIBBY ASBESTOS SITE OPERATIONAL UNIT 7 OUTDOOR AMBIENT AIR MONITORING WORK PLAN

FOR THE

TROY ASBESTOS PROPERTY EVALUATION PROJECT

Prepared for:

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

REVIEWS AND APPROVALS

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ACRONYMS AND ABBREVIATIONS

AHERA	Asbestos Hazard Emergency Response Act
CFR	Code of Federal Regulations
CDM	Camp, Dresser, and McKee
COC	Chain-of-custody
CPR	Cardiopulmonary resuscitation
DEQ	Montana Department of Environmental Quality
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
ESAT	Environmental Services Assistance Team
f/cc	Fibers per cubic centimeter
FSDS	Field sampling data sheets
HASP	Health and safety plan
LA	Libby amphibole
OSHA	Occupational Safety and Health Administration
OU	Operable unit
PDF	Portable document format
PPE	Personal protective equipment
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
SOP	Standard operating procedure
STEL	Short term exposure limit
Tetra Tech	Tetra Tech EM Inc.
TEM	Transmission Electron Microscopy
TWA	Time-weighted average
UCL	Upper Confidence Limit
µm	micron or micrometer

1.0 PROJECT DESCRIPTION AND BACKGROUND

Tetra Tech EM Inc. (Tetra Tech) received Task Order No. 44 from the Montana Department of Environmental Quality, Remediation Division (DEQ), under DEQ Contract No. 407026. The purpose of Task Order 44 is to prepare a Remedial Investigation Work Plan (Work Plan) that outlines the procedures and data quality requirements for sampling outdoor ambient air within Troy Operable Unit Number 7 (OU7) of the Libby Asbestos Superfund Site. The United States Environmental Protection Agency (EPA) is the lead agency for the Libby Asbestos Superfund Site. DEQ is the lead agency for OU7 through a cooperative agreement with EPA. This Work Plan describes the sampling objectives, locations, measurement methods, and data quality objectives (DQOs) necessary to identify whether, and where, Libby amphibole asbestos is present in the outdoor ambient air of OU7. This information is being collected as part of the OU7 Remedial Investigation and will be used to support remedial decisions.

1.1 PROJECT BACKGROUND AND PURPOSE FOR SAMPLING

From the 1920s until 1990, an active vermiculite mine and associated processing operations were located at Libby. While it was in operation, the vermiculite mine in Libby may have produced 80 percent of the world's supply of vermiculite (EPA 2005). Processed and exfoliated vermiculite from the mine was used primarily for insulation in buildings and as a soil amendment. The Libby vermiculite deposit contains a form of amphibole asbestos, referred to as Libby amphibole (LA) asbestos. Mine workers were exposed to asbestos-contaminated materials at the mine and processing facilities, and they transported asbestos-contaminated dust to their homes on their clothes and equipment. For decades, the processing of vermiculite ore and the generation and disposal of waste materials resulted in widespread LA asbestos contamination of the Libby community. In 1999, EPA Region 8 dispatched an emergency response team to investigate media reports of LA asbestos contamination and high rates of asbestos-related disease in Libby.

EPA began investigations in Libby through a two-phased approach. The first phase was to determine if a time critical removal action was warranted in Libby to protect human health, to identify potential major source areas, and to identify the appropriate analytical methods for measuring concentrations of LA in those source materials (Camp Dresser & McKee [CDM] 2002). The second phase was to collect detailed information about airborne concentrations resulting from sources of contamination that are disturbed (CDM 2003b). The combined results from the two phases of the investigation demonstrate that:

- Exposure to LA is a threat to human health.

- Release of respirable LA fibers occurs when source materials are disturbed. Source materials include vermiculite insulation, vermiculite products (building materials) and process wastes, and contaminated soils.
- There is widespread presence of LA throughout the Libby area.

As a result of the findings from the two phases of the investigation, and because EPA listed the Libby Asbestos Superfund Site on the National Priorities List in 2002, a further investigation of residences and businesses in the Libby Operable Unit Number 4 (OU4) was warranted (EPA 2003b). EPA began the Libby Asbestos Superfund Site contaminant screening study, which was considered the first part of the Remedial Investigation, in 2002. The ongoing objective of the contaminant screening study is to obtain information concerning the presence and nature of LA contamination at properties in OU4 (CDM 2003a). As of June 2009, EPA and their contractors had investigated approximately 3,675 properties in OU4 through the contaminant screening study.

Troy, Montana is located 18 miles northwest of Libby, Montana and is part of the Libby Asbestos Superfund Site. Many of the vermiculite mine employees resided in Libby; however, some of the workers lived in Troy and commuted daily to Libby to work at the mine. Residents of Troy also traveled to Libby for everyday activities such as shopping, working (other than at the mine), and attending school sporting events; they likely came in contact with vermiculite in Libby during these frequent visits. In addition, similar to what has been documented in Libby, the asbestos-contaminated vermiculite ore and waste materials may have been used for amending soils (as fill or as a conditioner), as building materials (plaster, concrete, or chinking amendment), or for insulating buildings in and around Troy. Additional outdoor ambient air contamination may have come from spills or placement as fill on transportation corridors, or from burning asbestos-contaminated wood.

The Remedial Investigation approach OU7 is similar to that of the contaminant screening study carried out for OU4, but makes improvements based on lessons learned from those activities. EPA believes that the nature of LA contamination and associated exposure pathways present in OU7 are similar to those observed in OU4. Limited investigations in OU7 thus far have found that the vermiculite insulation is similar in both morphology and mineralogy to the LA found in OU4 (USGS 2005). The draft OU7 Conceptual Site Model (Section 1.2) illustrates that potential exposures in OU7 are similar to those in OU4. Therefore, a systematic screening of Troy area residences, public areas, schools, businesses, and outdoor ambient air is necessary to gather sufficient information to determine how many Troy area properties are contaminated with LA and how these contaminated properties contribute to outdoor ambient air conditions.

1.2 CONCEPTUAL SITE MODEL

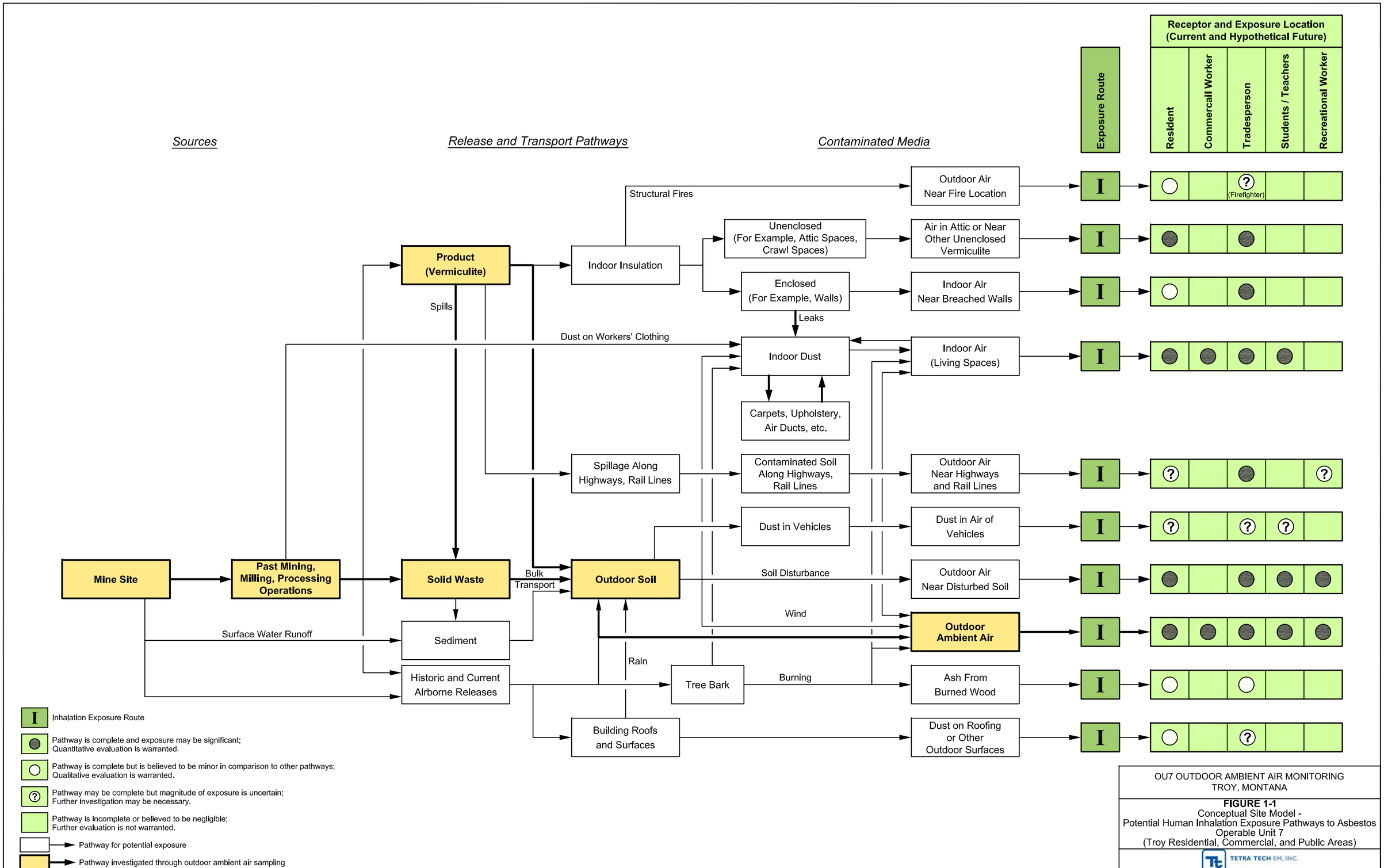
Exposure to airborne LA through inhalation is the main exposure route of concern for the potential development of malignant and non-malignant respiratory diseases. Oral ingestion of LA in environmental settings may also be a potential route of exposure and concern, but acquisition of the data to fully evaluate the ingestion of LA is not included in this Work Plan. The primary potential exposure pathways of LA are inhalation of outdoor ambient air, air near disturbed soil, and indoor air. Additional potential exposure pathways include inhalation of air near unenclosed sources (such as in attics), and air near breached walls. The draft conceptual site model will be refined as additional data are acquired and the understanding of actual transport and exposure pathways for OU7 is improved. It is not the intent of this Work Plan to investigate all pathways identified in the conceptual site model. Figure 1-1 presents a draft conceptual site model for OU7 and identifies only the exposure pathways by which LA fibers from the Libby mine might be inhaled by humans. It shows the specific pathway (outdoor ambient air) to be investigated under this Work Plan. Future work plans may be prepared to investigate the remaining pathways.

1.3 OU7 PHYSICAL CHARACTERISTICS

OU7 is located along the Kootenai River valley at an elevation ranging from 1,850 feet above mean sea level at the northern end to 2,500 feet above mean sea level on the mountain slopes surrounding the valley. OU7 is approximately 8 miles long and up to 1.8 miles wide. Topography of OU7 consists of relatively flat river valley terraces on both sides of a gently graded Kootenai River. Several tributaries flow into the Kootenai River along the 8-mile stretch within the OU. Figure 1-2 provides a topographic view of the OU7 boundaries.

1.4 SCHEDULE

Outdoor ambient air sampling is scheduled to begin in late summer 2009, and will continue for one year, at which time findings will be used to determine the need for additional sampling. Tetra Tech will complete a training session for all field staff involved in the outdoor ambient air sampling prior to initiation of sampling. Tetra Tech will comply with project reporting requirements which will be specified under future OU7 task orders.



OU7 OUTDOOR AMBIENT AIR MONITORING
TROY, MONTANA

FIGURE 1-1
Conceptual Site Model -
Potential Human Inhalation Exposure Pathways to Asbestos
Operable Unit 7
(Troy Residential, Commercial, and Public Areas)

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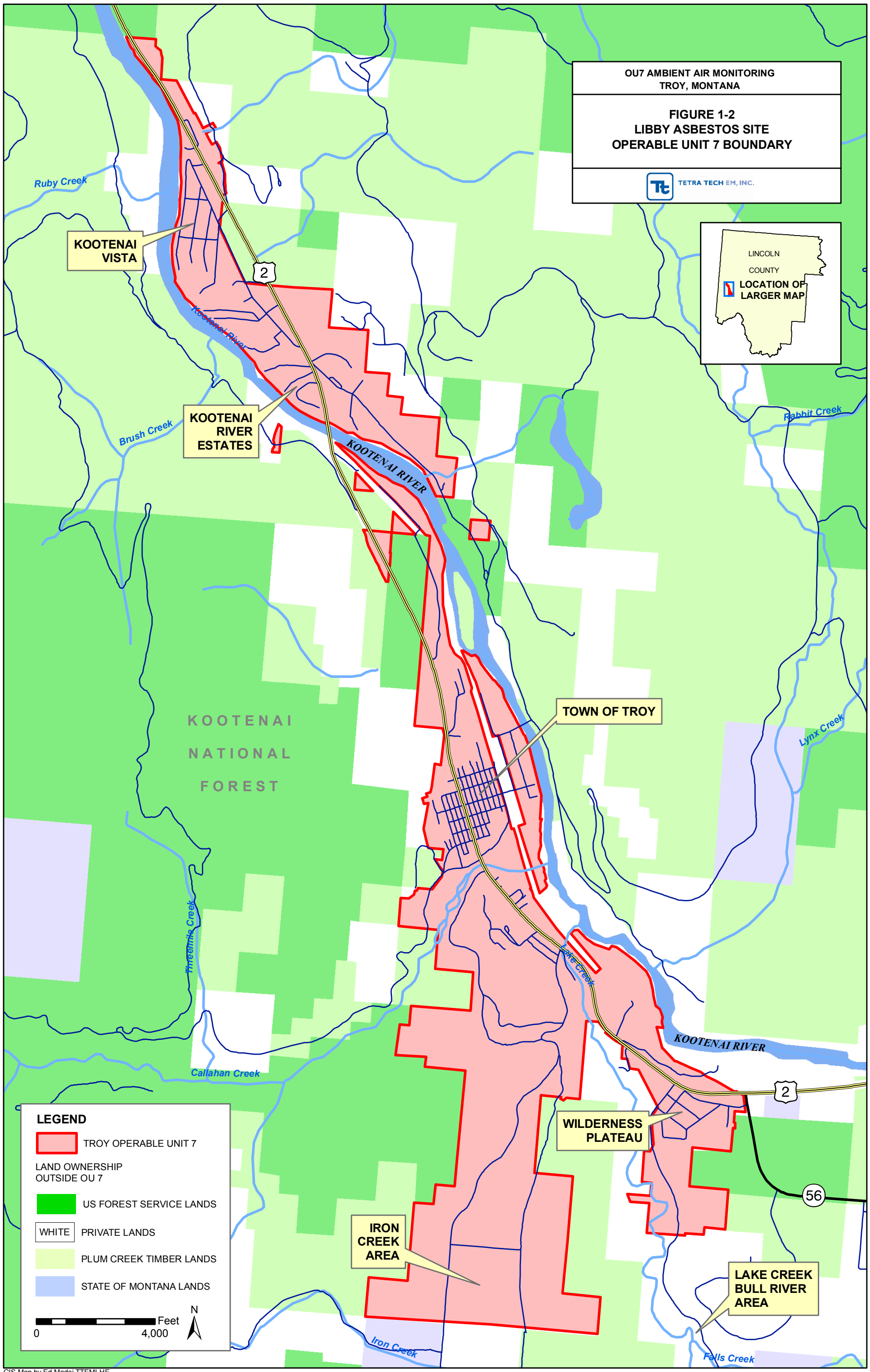
FIG_1-1_Conc Site Model.dwg - DWH - 08/13/2009



GIS Map by Ed Madej TTEMI-HE
FIG1-2_TROY_OU7_070909.MXD

1.5 WORK PLAN ORGANIZATION

This Work Plan is organized into seven sections. Section 1.0 is the introduction. The contents of sections 2.0 through 7.0 are briefly described below:

> **Section 2.0 Project Organization**. This section identifies key project personnel and project responsibilities, provides an organizational chart, and a table of participants, including contact information.
>
> **Section 3.0 Data Quality Objectives**. This section describes the DQO steps used to establish the quantity and the quality of data to support decision making.
>
> **Section 4.0 Field Procedures**. This section describes the activities that will take place during the outdoor ambient air sampling. The health and safety requirements, along with the health and safety plan (HASP), are referenced and detailed.
>
> **Section 5.0 Field Quality Control Procedures**. This section discusses the field quality assurance/quality control (QA/QC) procedures, including equipment decontamination, QC samples, field documentation, and chain-of-custody (COC). This section also discusses QA procedures used at the Libby Asbestos Superfund Site (CDM 2007).
>
> **Section 6.0 Data Management**. This section describes how data will be handled from collection to the point of transfer to the OU7 Ambient Air Scribe Database.
>
> **Section 7.0 QA/QC Procedures**. This section describes the procedures that will be followed to ensure the quality and integrity of the outdoor ambient air data as defined in the site-wide quality assurance project plan (QAPP) (CDM 2007).

References cited in this document are listed after Section 7.0. Tables and figures follow their first reference in the text. Appendix A **(on CD only)** provides the Troy Asbestos Property Evaluation site-specific HASP and a HASP amendment that addresses specific needs related to outdoor ambient air sampling. Appendix B contains the technical analysis used to determine the number of samples required for the project in DQO Step Number 7. Appendix C provides the Access Letter and Agreements for landowners. Appendix D contains the Troy Ranger Station Wind Rose and associated data. Appendix E provides a copy of the EPA Guidance Standard Operating Procedure (SOP) 2015. Appendix F contains SOP No. EPA-LIBBY-09 (rev 1) and the Grid Openings Calculation. Appendix G includes field forms to be used during sampling. Appendix H contains the Tetra Tech field audit checklist. Appendix I contains the Troy Record of Modification, and Appendix J contains the EPA Data Reporting Requirements for the Libby Asbestos Superfund Site (Version 10).

2.0 PROJECT ORGANIZATION

This section outlines key project personnel and project responsibilities for personnel involved in the outdoor ambient air sampling project. Table 2-1 identifies the responsibilities and contact information for key personnel. In some cases, more than one responsibility has been assigned to an individual. Figure 2-1 is an organizational chart that graphically represents the relationships between the different agencies, contractors, and other parties involved with the Libby Asbestos Site.

EPA and DEQ have agreed that DEQ is the lead agency responsible for performing the OU7 field work in support of the project. This work is funded by EPA through a cooperative agreement between EPA and DEQ. Specifically, DEQ, with the assistance of Tetra Tech, is responsible for performing community relations activities; obtaining access to properties; collecting the outdoor ambient air samples described in this Work Plan; performing sample labeling, handling, and tracking; and uploading field data into the OU7 Ambient Air Scribe Database. DEQ, through its contractor Tetra Tech, is responsible for sending field samples, under COC, to the Environmental Services Assistance Team (ESAT) contract laboratory, for analysis. Tetra Tech is responsible for management of the OU7 Ambient Air Scribe Database.

2.1 AGENCY OVERSIGHT

The DEQ Project Officer (or designee) provides oversight of all field activities associated with the project. DEQ and EPA oversight personnel have the authority to inspect all field and sampling activities, determine the appropriateness of the recorded data, and ensure that all activities comply with standard practices and meet the project objectives. Before any oversight is conducted, the Tetra Tech on-site health and safety coordinator will brief the DEQ and EPA oversight personnel to ensure safe practices are maintained throughout the field audit.

TABLE 2-1

KEY PERSONNEL ROLES AND RESPONSIBILITIES

Name	Organization	Role	Responsibilities	Contact Information
Catherine LeCours	DEQ	Project Officer	• Monitors performance of the contractor • Reviews and approves QA measures • Consults with the EPA • Reviews and approves all Work Plans • Provides coordination with ESAT and EPA • Provides primary interface with interested parties and the OU7 community and disseminates project information to the public	Montana Department of Environmental Quality PO Box 200901 Helena, MT 59620-0901 clecours@mt.gov (406) 841-5040 (406) 431-1630 (cell)
J. Edward Surbrugg & Katy Norris	Tetra Tech	Project Manager	• Implements all activities called out in the task order • Supervises preparation of Work Plan and approves document • Monitors and directs field activities to ensure compliance with Work Plan requirements • Provides coordination with DEQ Project Officer • Disseminates project information to interested parties and OU7 property owners, and directs questions to DEQ • Provides DEQ Project Officer and project manager with regular reports on status of field activities	Tetra Tech, Helena, MT 7 West 6th Avenue Helena, MT 59601 edward.surbrugg@ttemi.com (406) 442-5588 (406) 459-0881 (cell) kathryn.norris@ttemi.com (406) 442-5588 (406) 431-2546 (cell)
Mark Stockwell	Tetra Tech	Field Team Manager and Field Office Manager	• Conducts training of personnel • Directs and coordinates field activities conducted by Tetra Tech • Assures compilation, organization, and auditing field data sheets submitted by field staff • Verifies that field sampling and measurement procedures follow Work Plan • Disseminates project information to interested parties and OU7 property owners, and directs questions to Project Manager or DEQ	Tetra Tech, Sandpoint, ID 324 Larchwood Drive Sandpoint, ID 83860 mark.stockwell@ttemi.com (208) 263-4524 (916) 715-8442 (cell)

TABLE 2-1 (Cont.)

KEY PERSONNEL

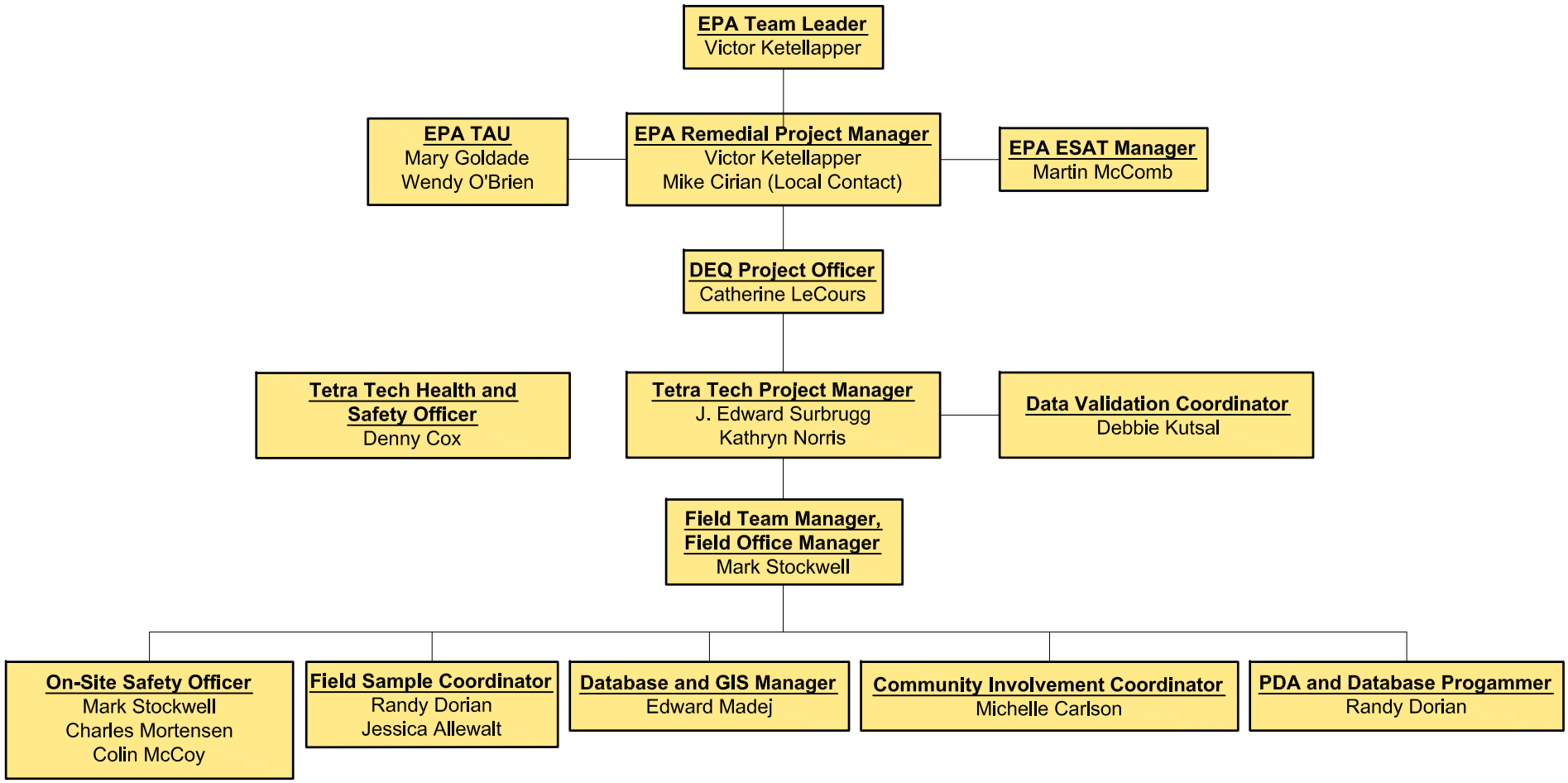
Name	Organization	Role	Responsibilities	Contact Information
Denny Cox	Tetra Tech	Tetra Tech Health and Safety Officer	• Approves the OU7 Health and Safety Plan • Provides a resource for all health and safety issues	Tetra Tech 415 Oak Street Kansas, City, Missouri 64106 denny.cox@ttemi.com (816) 412-1747 (816) 668-7464 (cell)
Colin McCoy, Mark Stockwell, and Jay Jordan	Tetra Tech	On-Site Safety Officer	• Implements health and safety plan, and determining appropriate site control measures and personal protection levels • Conducts safety briefings for Tetra Tech and site visitors	Tetra Tech 7 West 6th Ave. Helena, MT 59601 colin.mccoy@ttemi.com (406) 442-5588 mark.stockwell@ttemi.com (208) 263-4524 jay.jordan@ttemi.com (406) 295-9238
Randy Dorian	Tetra Tech	Field Sample Coordinator; PDA and Database Programmer	• Management of OU7 Ambient Air Scribe Database • Ensure secure sample information is collected and transferred to EPA • Disseminates project information to interested parties and OU7 property owners and directs questions to Project Manager or DEQ	Tetra Tech, Denver, CO 518 17th Street, Suite 900 Denver, CO 80202 randy.dorian@ttemi.com (303) 312-8832
2 Members	Tetra Tech	Field Staff Member And Site Safety Officers	• Performs sampling activities as described in this Work Plan • Ships samples to ESAT laboratory under COC protocol • Disseminates project information to interested parties and OU7 property owners, and directs questions to Project Manager or DEQ • Follows HASP and reports any and all safety concerns to the Site Safety Coordinator • Suspends operations that threaten health and safety • Conducts safety briefings for Tetra Tech and site visitors	Tetra Tech DEQ Troy Information Center 303 N. Third Street P.O. Box 1170 Troy, MT 59935 (406) 295-9238

TABLE 2-1 (Cont.)

KEY PERSONNEL

Name	Organization	Role	Responsibilities	Contact Information
Victor Ketellapper	EPA	Team Leader and Remedial Project Manager	• Coordinates overall Libby Asbestos Superfund Site • Maintains oversight of schedule and budget • Approves Work Plans and modifications • Coordinates with DEQ • Coordinates independent field audit if necessary	U.S. EPA, Region 8 1595 Wynkoop Street Denver, CO 80202-1129 ketellapper.victor@epa.gov (303) 312-6578

Notes:
COC Chain of Custody
DEQ Montana Department of Environmental Quality
EPA U.S. Environmental Protection Agency
ESAT Environmental Services Assistance Team
OU7 Operable Unit 7
QA Quality assurance/quality control
Tetra Tech Tetra Tech EM Inc.



Legend (Acronyms)

DEQ - Montana Department of Environmental Quality
EPA - Environmental Protection Agency
ESAT - EPA Environmental Services Assistance Team
GIS - Geographic Information System
PDA - Personal Digital Assistant
TAU - Technical Advisory Unit

OU7 OUTDOOR AMBIENT AIR MONITORING
TROY, MONTANA

FIGURE 2-1
Organization Chart

TETRA TECH EM, INC.

FIG_2-1_Organization Chart.dwg - DWH - 07/29/2009

2.2 SPECIAL TRAINING AND CERTIFICATES

Tetra Tech personnel who do field work on the outdoor ambient air sampling project will have met the Occupational Safety and Health Administration (OSHA) training requirements defined in Title 29 Code of Federal Regulations (CFR) Part 1910.120(e) for working at hazardous waste sites. These requirements include: (1) 40 hours of formal off-site instruction, (2) a minimum of 3 days of actual on-site field experience under the supervision of a trained and experienced field supervisor, and (3) 8 hours of refresher training annually. In addition, at least one member of each Tetra Tech field staff will possess current certification in the American Red Cross "Multimedia First Aid" and "Cardiopulmonary Resuscitation (CPR) Modular" or equivalent, and at least one member of the field staff will hold a current Asbestos Hazard Emergency Response Act (AHERA) asbestos inspector training certificate. All field staff members will be trained to properly handle the health and safety protocols for this project.

Tetra Tech personnel working on the project must read and abide by the stipulations and guidelines set forth in Tetra Tech's HASP and this project specific amendment (Appendix A). The HASP provides written instructions for health and safety training requirements, personal protective equipment (PPE) requirements, a spill containment program, and health-hazard monitoring procedures and techniques. Copies of Tetra Tech's health and safety training records, including course completion certifications for the initial and refresher health and safety training, specialized AHERA training, and first aid and CPR training, are maintained in the Helena Tetra Tech office files for all field staff members.

Before field work begins, Tetra Tech personnel are required to undergo site-specific training that thoroughly covers the following areas:

- Implementation of this Work Plan and all Records of Modification
- Names of personnel and alternates responsible for health and safety at a project site
- Health and safety hazards present on site, including heat, cold, physical stressors, insects, ticks, and other potential hazards
- LA-specific morphology and health risks
- Selection of the appropriate personal protection levels
- Correct use of PPE
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment on site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazardous substances, physical stressors (heat, cold), and other potential hazards
- Contents of the HASP
- Community relations

3.0 DATA QUALITY OBJECTIVES

This section contains the DQOs for the outdoor ambient air sampling project. The DQOs are qualitative and quantitative statements developed through the seven-step DQO process (EPA 2000a; EPA 2006a). The DQOs help to clarify the study objectives, define the most appropriate data to collect and the conditions under which to collect the data, and specify tolerable limits on decision errors that will be used as the basis for establishing the quantity and quality of data needed to support decision-making. The DQOs are used to develop a scientific and resource-effective design for data collection.

STEP 1 – STATE THE PROBLEM

The purpose of this step is to describe the problem to be studied so that the focus of the investigation will be unambiguous.

Previous investigations have determined that LA is present in multiple environmental media in Libby and Troy. These include indoor air, outdoor ambient air, indoor dust, vermiculite-containing insulation, and soil. As a result, residents in and around Libby and Troy may be exposed to LA, and these exposures may present an unacceptable risk of adverse health effects under certain exposure conditions.

The potential cumulative exposure of residents and workers to LA in OU7 is currently unknown. In combination with discrete data collected for other exposure routes, data on LA concentrations in outdoor ambient air are needed to support human health risk assessment and the need for future remedial actions.

STEP 2 – IDENTIFY THE DECISION

The decisions DEQ and EPA are seeking to make are: (1) whether the levels of LA in outdoor ambient air contribute a risk of cancer or non-cancer effects, either alone or in combination with other exposure pathways; (2) whether that risk is within an acceptable range of risks under a reasonable maximum exposure scenario; and (3) whether the data identify any significant differences of the levels of LA in outdoor ambient air as a function of time or location in OU7.

STEP 3 – IDENTIFY THE INPUTS TO THE DECISION

The purpose of this step is to identify the environmental data that need to be obtained and the measurements that need to be taken to resolve the decision statements.

The key environmental data required to estimate cancer and non-cancer risks from exposure to LA in outdoor ambient air are reliable and representative (over location and time) data on the long-term average concentration of LA in outdoor ambient air within OU7. The long-term average value for a specified area and time frame is the key determinant of the cancer and non-cancer risk to residents and workers exposed in that area and time.

In this regard, it is important to recognize that there are several alternative strategies for specifying the concentrations of LA in air, and how to use those data to estimate exposure and risk. At present, final decisions have not been made regarding which approach(es) will be used, so it is important that the analytical data obtained contain the full details on the particle size (length, width, mineral type) of all asbestos structures observed, so that these data can be used to compute the appropriate concentration values for use in whatever alternative risk models may be selected for the site.

STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

This step specifies the spatial and temporal boundaries of this investigation.

Spatial Bounds

Vermiculite and other LA-contaminated wastes were historically transported from the Libby mine and randomly placed on properties in OU7. Similarly, the use of vermiculite-containing insulation in homes and other buildings in OU7 is random. DEQ has therefore determined that the study area for outdoor ambient air sampling will be the entire area within the OU7 boundary, including residential properties, commercial properties, schools, parks, and all publicly-owned property.

Temporal Bounds

The program will begin in fall 2009, and is scheduled to continue for one year in order to ensure that temporal variability on the scale of days and months is adequately captured in the data set. Temporal bounds include the changing of weather patterns, particularly wind speed and direction, over time. A summary of historical meteorological conditions and impacts on placement of outdoor ambient air sampling equipment is presented in section(s) 4.4.1 and 4.4.2. If additional data is needed to improve the temporal representativeness of the data set and/or to collect data that will allow an assessment of long-term trends that may arise from any removal or remedial actions, then the program could be extended for several years. These decisions will be made by the risk managers once the data collected from the initial year are evaluated, and after consultation with EPA's scientific support team at the site.

STEP 5 – DEVELOP DECISION RULES

The purpose of this step is to describe the method that DEQ and EPA will use to make final risk management decisions from the data.

At present, risk management decision rules for the site have not yet been defined. Because outdoor ambient air is only one of several exposure pathways that will be evaluated as part of the baseline human health risk assessment, it is expected that the decision rule for outdoor ambient air will be that the residual cancer and non-cancer risk associated with the reasonable maximum exposure scenario contributed by this pathway may not exceed some specified level (either an absolute level or alternatively, some proportion of the total risk).

In the absence of a quantitative decision rule, the risks associated with inhalation of LA in outdoor ambient air under reasonable maximum exposure conditions are assumed to approach or exceed an excess cancer risk level of 1E-05 (one in 100,000), or a non-cancer hazard quotient of 0.1, in order to plan the monitoring program. Based on this assumption, the outdoor ambient air pathway may be an important contributor to the total cumulative risk, and that, in this case, the sampling program should have a high ability to detect and reliably quantify the concentrations of LA in outdoor ambient air. This assumption is for planning purposes and should not be interpreted as a risk management decision since final risk management decisions will consider the cumulative risk of exposure to multiple exposure pathways. This assumption is used only to support initial efforts necessary to plan the sampling program.

STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

The tolerable limits on decision errors, used to establish performance goals for the data collection design, are specified in this step.

In making risk management decisions with calculated estimates of exposure and risk, two types of decision errors are possible:

- A Type I (false negative) decision error would occur if a risk manager decides that exposure to LA in outdoor ambient air is not of significant health concern, when in fact it is of concern.
- A Type II (false positive) decision error would occur if a risk manager decides that exposure to LA in outdoor ambient air is above a level of concern, when in fact it is not.

EPA is most concerned about guarding against the occurrence of Type I errors, since an error of this type may leave humans exposed to unacceptable levels of LA in outdoor ambient air. For this reason, it is anticipated that the exposure assessment for this pathway will be based on the best estimate and the 95

percent upper confidence limit (UCL) of the long-term average concentration of LA in the area being evaluated. Use of the UCL to estimate exposure and risk helps account for limitations in the data, and provides a margin of safety in the risk calculations, ensuring that risk estimates are unlikely to be too low.

EPA is also concerned with the probability of making Type II (false positive) decision errors. Although this type of decision error does not result in unacceptable human exposure, it may result in unnecessary expenditure of resources. For the purposes of this effort, the strategy adopted for controlling Type II errors is to ensure that, if the risk estimate based on the 95 percent UCL is above EPA's level of concern for this pathway, then the UCL is not larger than 3-times the best estimate of the mean. If the 95 percent UCL is at or above the range that is of potential concern, and the UCL is greater than 3 times the best estimate of the mean, then more data may be needed.

STEP 7 – OPTIMIZE THE DESIGN FOR OBTAINING DATA

This section outlines how the necessary number of samples was determined using outdoor ambient air data collected in OU4 from 2007 to 2008 (EPA 2009a; EPA 2009b). It also outlines the necessary analytical sensitivity for the data collection. Additional detailed information and calculations are based on SOP No. EPA-LIBBY-09 (rev 1) and the computation for the number of grid openings (Appendix F).

Estimating the Number of Samples Required

Tetra Tech followed the EPA approved work plan for OU4 (EPA 2006b) to create the exposure point concentration (EPA 1992, 2009a, 2009b). The approach used for determining sample minimum size requirements is in Appendix B.

For a sample of size n = 100, one should expect that LA will be detected in 11 to 16 of these samples. This number is unlikely to be sufficient to support a robust estimate of the UCL for a lognormal distribution. In order to assure a minimum of 20 to 25 detected results, Tetra Tech recommends a target sample-size in the range of at least 150 to 200 discrete samples.

Estimating the Required Analytical Sensitivity

The assumed analytical sensitivity must be sufficient to ensure reliable detection and quantification of risks from LA. For this Work Plan, the estimated required analytical sensitivity must detect an excess of cancer risk of 1E-05 (1 in 100,000) or a non-cancer hazard quotient of 0.1 in outdoor ambient air. The concentrations associated with these risk levels may be estimated.

For cancer, a simplified equation for computing the risk associated with some specified concentration is:

Risk = C x TWF x UR

Where:

Risk = risk of lung cancer or mesothelioma from the exposure being evaluated
C = long-term average concentration of asbestos (fibers per cubic centimeter [f/cc])
TWF = time weighting factor (percent of full time that exposure occurs)
UR = unit risk for lifetime exposure

The target analytical sensitivity is then computed by rearranging the equation as follows:

Target Analytical Sensitivity $\leq$ 1E-05 / (TWF x UR)

For planning purposes, Tetra Tech made the conservative assumption that the TWF is 1.0 as used in the outdoor ambient air analysis conducted in OU4 (EPA 2006b). This corresponds to an outdoor ambient air exposure that occurs 24 hrs/day for a lifetime (actual exposures are likely to be lower than this for most people). Based on EPA's currently recommended risk model (IRIS 2006), the unit risk factor for lifetime exposure is 0.23. Thus, the level of concern for LA in air would be about:

Target Analytical Sensitivity $\leq$ 1E-05 / 0.23 = 0.00004 f/cc

For non-cancer effects, the basic risk equation is:

HQ = C x (ET/24 x EF/365 x ED) / RfC

Where:

HQ = hazard quotient (dimensionless)
C = long-term average concentration of asbestos in air (f/cc)
ET = exposure time (hrs/day)
EF = exposure frequency (days/yr)
ED = exposure duration (yrs)
RfC = Cumulative Reference concentration (f/cc-yrs)

At present, no RfC has been established for evaluating non-cancer effects from inhalation of LA, so one cannot compute an analogous level of concern for this endpoint. In the absence of such data, the target analytical sensitivity that is adequate for evaluating cancer risk must be assumed to also be sufficient for evaluating non-cancer risks. This assumption will be re-visited when an RfC is developed. Thus, the target analytical sensitivity for outdoor ambient air samples will be $\leq$0.00004 f/cc.

Refining the Design as Data are Collected

In accordance with EPA's DQO process, the outdoor ambient air sampling program described in this document may be modified periodically as data are obtained. For example, if data suggest that the variability in concentrations of LA over time is low, then DEQ may decrease the number of samples collected over a specified period of time. Alternatively, if data suggest that the variability in concentrations of LA over geographic areas is higher than expected, then additional sampling stations may be added to better characterize the spatial variability. Similarly, the target analytical sensitivity may be either increased or decreased, depending on the detection frequency and mean values observed in initial samples results, and on the RfC value, when it becomes available.

4.0 FIELD PROCEDURES

This section describes the field activities to be implemented for the outdoor ambient air sampling and includes the following tasks:

- Health and safety requirements
- Site access and logistics
- Pre-sampling activities
- Collecting outdoor ambient air samples

Each of the above tasks is summarized below. Information on QC is in sections 5.0 and 7.0. Health and safety protocols and requirements will apply to all field activities.

4.1 HEALTH AND SAFETY PROCEDURES

The Tetra Tech HASP amendment is included as part of the TAPE HASP (Appendix A). The HASP, including the amendment and Tetra Tech's corporate health and safety program plan, will apply to all field activities undertaken as part of this project. All field staff conducting inspection and sampling activities will be required to:

1. Hold a current OSHA hazardous waste operations 40-hour training certification and up-to-date 8-hour refreshers, as required under 29 CFR 1910.120;
2. Have medical clearance to work wearing a full-face or half-face air purifying respirator; and
3. Be qualitatively fit-tested for the specific project respirator within the 12 months prior to the field activities.

The HASP amendment in Appendix A provides detailed health and safety protocols and requirements, including directions for when to use PPE, such as respirators. Mark Stockwell will be the Tetra Tech Field Team Manager and Site Safety Officer, and Colin McCoy will be the Site Safety Coordinator (Table 2-1) as well as identified field staff who will also serve as the site leads for health and safety activities when Mr. Stockwell and Mr. McCoy are not present. The Tetra Tech field staff will also report any safety concerns to the Site Safety Coordinator or Site Safety Officer whether or not they are present at the site.

Work that may result in potential employee exposure to airborne asbestos above the prescribed permissible exposure limit or short-term exposure limit requires an exposure assessment regulated under the OSHA reference method 29 CFR Part 1910.1001. The determination of employee exposure will be made from breathing-zone air samples representative of the 8-hour time-weighted average (TWA) and 30-minute short-term exposure limit (STEL) for each employee work category. The permissible exposure limits are 0.1 f/cc for the 8-hour TWA, and 1.0 f/cc over a 30-minute period for the STEL, per 29 CFR Part 1910.1001 (j)(2)(iii). To demonstrate compliance with these limits, exposure assessments for the field staff will be performed during the initial stage of the outdoor ambient air sampling, and as necessary during the process, as described in the HASP, and at the direction of the Site Safety Officer. Until determinations of employee exposure have been calculated, Tetra Tech personnel will wear Level C PPE with half mask respirators and P100 cartridges. If the exposure is below the permissible limit, only Level D PPE will be required for the remaining outdoor ambient air sampling project. Tetra Tech personnel will explain to the landowners and any concerned citizens that respirators are only necessary because the personnel are handling potentially concentrated samples.

4.2 SITE ACCESS AND LOGISTICS

Section 4.2 provides information about community relations, logistics and schedules, and site access agreements.

4.2.1 Community Relations and Information Centers

Tetra Tech will coordinate with DEQ to ensure that appropriate public outreach is completed before, and continues after, the implementation of the outdoor ambient air sampling program. Tetra Tech will, at the request of DEQ, provide personnel to attend public meetings in Troy and will help prepare presentation materials.

Tetra Tech and DEQ will provide public information regarding the outdoor ambient air sampling at the DEQ Troy Information Center, at 303 N. Third Street, Troy, Montana. The DEQ Troy Information Center will also serve as the Tetra Tech Troy field office, and will be the logistical center for the outdoor ambient air sampling activities, and for sending samples from Tetra Tech to the ESAT laboratory in Golden, Colorado. The DEQ Troy Information Center will have telephones and answering machines for contacting project personnel when the office is not staffed. Summer hours at the Information Center are Monday through Friday from 8:00 am until 4:30 pm. Fall/winter hours are Tuesday through Thursday from 8:00 am until 4:30 pm.

The EPA Information Center, at 501 Mineral Avenue in Libby, Montana may also be an information resource for OU7 residents, providing access to documents related to the Libby Asbestos Site. Information about the Libby Asbestos Superfund Site is also available on the Internet at http://www.epa.gov/region8/superfund/libby/index.html. DEQ will maintain updated information regarding OU7 on this webpage.

Section 2.0 of this Work Plan discusses the roles and responsibilities of the DEQ and Tetra Tech in disseminating the project information to interested parties and to OU7 property owners.

4.2.2 Logistics and Schedule

DEQ and Tetra Tech will staff the DEQ Troy Information Center for the duration of field activities (regular hours and winter hours of operation provided in Section 4.2.1). Tetra Tech and DEQ will identify and provide all necessary personnel, sampling equipment, PPE, and project materials for implementing this Work Plan. All Tetra Tech field staff will be trained on both the overall objectives of the project and on specific tasks. This training will facilitate implementation and allow for effective communication with the public and other team members.

The Tetra Tech Project Manager will oversee all project activities and logistics, and will ensure that effective lines of communication are maintained to resolve any issues or concerns that may arise during the field efforts. The Tetra Tech Project Manager will reside in Helena, but will be at the project location when necessary to monitor field activities. The Tetra Tech Data Manager has primary responsibility to ensure secure sample information is collected and transferred to EPA.

To ensure consistency, Tetra Tech will provide two field staff members to be stationed in Troy for the duration of the outdoor ambient air sampling activities. All field staff members will complete on-site training for outdoor ambient air sample collection, community relations, and health and safety.

Tetra Tech will collect outdoor ambient air samples from seven sampling stations continuously for five consecutive days (120 hours). This will be considered a (one) sampling event. Stations will be active for five days, and then inactive for five days, until the next sampling event. This cycle will continue for one year. Additional details on the sampling schedule and process are discussed in Section 4.4.6.

4.2.2.1 Communications

Field staff, with the DEQ Troy Information Center as their base, will be provided with cellular phones during field activities. Emergency numbers and contact information for all Tetra Tech project and management personnel located in Helena, Montana will be stored in the phone. In addition, these numbers will be placed in the field vehicle and displayed in the DEQ Troy Information Center. The DEQ Project Officer and EPA Libby Asbestos Superfund Site personnel will be provided with the contact information for the Tetra Tech field staff. The cellular phone numbers will only be given to Tetra Tech personnel, DEQ, EPA, and the owners of the properties on which the air sampling stations are placed.

4.2.2.2 Equipment and Supplies

DEQ and Tetra Tech will obtain the outdoor ambient air sampling equipment necessary for activities described in this Work Plan by purchasing new monitoring equipment and supplies for each sampling station or borrowing existing equipment from OU4 as appropriate. The Tetra Tech field staff will inspect the equipment prior to field use to ensure they are in proper condition and free of defects. Tetra Tech will order new sampling air cassettes from appropriate suppliers. Additional details regarding sampling station design and equipment and supplies are discussed in Section 4.4.

4.3 PRE-SAMPLING ACTIVITIES

Prior to beginning field activities, Tetra Tech will hold a field planning meeting, assist DEQ with community involvement activities, complete an inventory of equipment and supplies to determine procurements needs, identify station locations, and construct the ambient air and meteorological sampling stations. The following sections discuss these pre-sampling activities.

4.3.1 Field Planning Meeting

The Tetra Tech Field Staff Manager will conduct a field planning meeting, which will be attended by the field staff, a member of the QA staff, and DEQ personnel. The DEQ Project Officer will be notified of the date and time of the meeting. The agenda will be reviewed and approved by DEQ, the QA staff, and the Site Safety Officer prior to the meeting. The meeting will briefly discuss and clarify:

- Objectives and scope of the fieldwork
- Equipment and training needs
- Field operating procedures, schedules of events and individual assignments
- Required QC measures
- Health and safety requirements
- Documents governing fieldwork that must be on site
- Any changes in the field plan documents

Tetra Tech QA staff will distribute a written agenda and an attendance list to be signed by meeting attendees. Copies of these documents will be maintained in the project files. Additional meetings will be held as necessary when sampling conditions change significantly or when the scope of the outdoor ambient air sampling changes significantly.

The field staff will perform the following activities before and during field activities, as applicable:

- Review and understand this Work Plan and HASP
- Ensure that all sample analyses are scheduled through the laboratory
- Obtain required asbestos sampling cassettes and other supplies
- Obtain and maintain field sampling equipment
- Obtain and maintain PPE

4.3.2 Community Coordination

Prior to the implementation of the sampling events described in this Work Plan, DEQ and Tetra Tech will contact the property owners where sampling is proposed to determine their desire to participate and explain the details and expectations of the sampling program. The property owner will be advised on the study's duration (at least a year and perhaps longer), and will be informed of the importance of obtaining samples consistently over that extended period. DEQ will obtain signed access agreements specifically for the outdoor ambient air sampling program (Appendix C). Tetra Tech personnel will explain to each resident the program and the potential impact to the resident (e.g., installation of the housing unit, sample technicians visiting the property at regular intervals, and the expected duration of the program). Tetra Tech will request that the residents inform them two days prior to any site disturbance around a sampling station. Any property damage or disturbances, made to the site by installation or removal of the sampling stations, will be repaired by Tetra Tech.

4.3.3 Inventory and Procurement of Equipment and Supplies

The following equipment will be required for sampling activities. Tetra Tech will procure any required equipment not already contained in the field equipment supply inventory prior to initiation of sampling activities.

- Air sampling equipment (11 SKC AirCheck2000 Pumps or equivalent, 11 battery eliminator cables, 10 12-volt deep cycle batteries)
- Sample media – 0.45 micrometer (µm) pore size, 25-millimeter diameter mixed cellulose ester filter cassettes
- 100 feet of ¼-inch internal diameter tubing to connect filter to pump
- Meteorological station equipment (equipped with CR200 data logger)
- Sample paperwork and sample tags/labels
- Zipper-top baggies
- Custody seals
- Digital camera
- Indelible ink pens
- PPE as required by the HASP

The list above is not intended to be exhaustive, but an example of general necessary supplies.

4.3.4 Define Sampling Locations and Sample Station Identification Numbers

Sampling stations will be located in four outdoor ambient air sampling zones. Final sampling locations will be decided prior to initiation of sampling based on site logistics, landowner agreement, and site security. Tetra Tech will assign unique Sample Station Identification Numbers to all stations. A detailed discussion of how station locations will be determined is provided in Section 4.4.2.

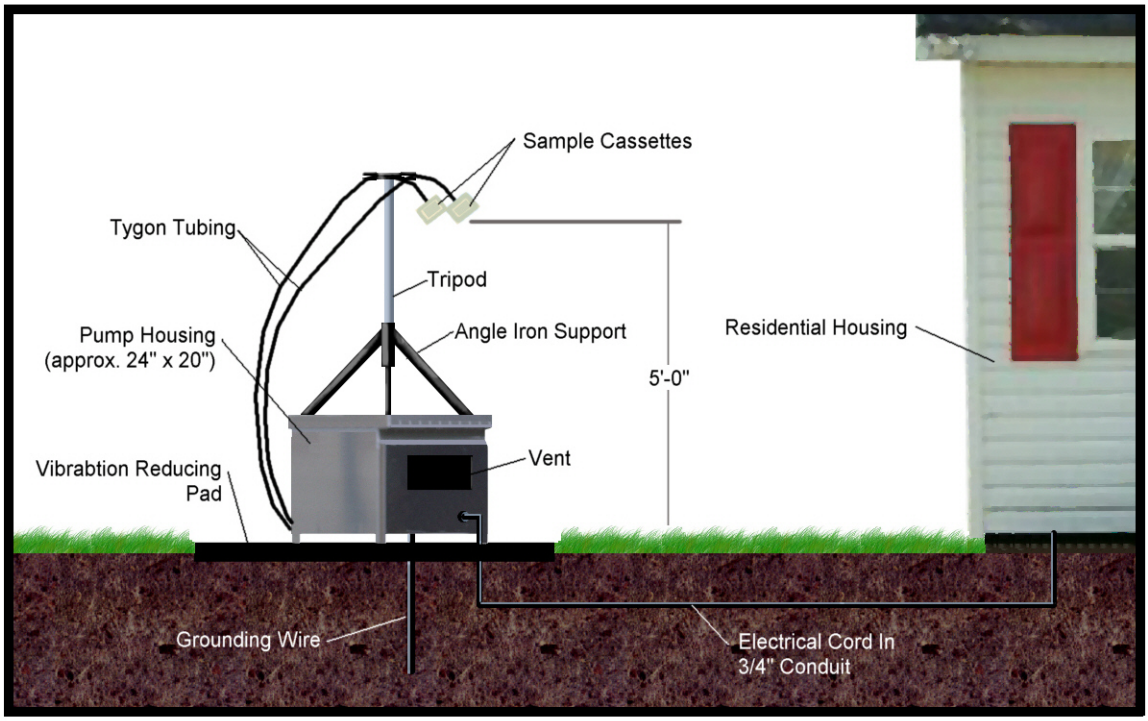
4.3.5 Sample Station Construction

Tetra Tech will construct outdoor ambient air sampling stations generally following the design shown in Figure 4-1. Tetra Tech will inspect station equipment for defects prior to construction of the sampling stations. Each station will have a label identifying the station, the landowner, the DEQ Troy Information Center phone number and address, and a telephone number to call in case of an emergency. Each station will be equipped with a lock. Tetra Tech personnel will lock the stations whenever they are leaving the site and they will remained locked whenever Tetra Tech is not present at the station site.

Tetra Tech plans on using batteries to power the stations, but may need to supply power to the stations for heating purposes during the winter. If batteries are the only source of power, then an electrical connection, grounding wire, and conduit to the residence or building will not be required. A battery powered station is preferred for several reasons: 1) trenching for electricity would not be required; 2) it may be easier to solicit homeowners for participation; 3) there would be the potential to position a station on public land; and 4) it would provide an overall cost savings to the project. If Tetra Tech disturbs any areas by station installation, they will be restored to their previous condition after installation and again after removal of the station. If electrical installation is required, the electrical work will be performed by a journeyman electrician. DEQ will reimburse the owners for any electricity used at the site for sampling

purposes. Tetra Tech personnel will disassemble all stations and decontaminate them at the conclusion of the project.

Figure 4-1 Proposed Sample Station Construction Diagram



4.3.6 Meteorological Station

Tetra Tech will construct a meteorological station at the DEQ Troy Information Center to collect meteorological data during the sampling events. The station will be equipped with a CR200 data logger (or equivalent) that is capable of recording the average wind speed, wind direction, temperature, humidity, pressure and precipitation at hourly intervals during each 120-hour sampling event. Tetra Tech field staff will download the data from the data logger at the end of each sampling event, or as deemed necessary.

4.4 OUTDOOR AMBIENT AIR SAMPLING

The following sections describe historical wind patterns of OU7 and the process of selection of outdoor ambient air sampling locations, the procedures for sample collection, and requirements for collection and submission of QA/QC samples.

4.4.1 Historical Wind Patterns of OU7

Tetra Tech obtained historical wind data for the Troy area from the US Forest Service Troy Ranger Station (Appendix D). The ranger station is located 1.6 miles north of the town of Troy on US Highway 2. Wind roses were used to summarize the wind patterns from 1999 to 2009. Calm conditions were recorded for 16.1 percent of the 10-year period. Predominant winds in the area blow in south, south-southeast, and northwest directions. This is probably due to topography of the river corridor in which Troy is located (which runs in a northwest to southeast direction). The dominant wind was from the south-southeast. These winds occurred 14.4 percent of the time with an average speed of 4.8 miles per hour. Winds flowed from the south 12.3 percent of the time with an average speed of 3.4 miles per hour, and from the north-northwest 9.5 percent of the time with an average speed of 4.1 miles per hour. Table 4-1 describes the wind direction and average speed. The wind rose and associated data is in Appendix D.

TABLE 4-1
WIND DIRECTIONS IN TROY, MT

Wind Direction (from)	Percent (%) of Recorded Time*	Average Speed (mph)
Calm	16.1%	0.0
N	6.3%	3.3
NNE	2.2%	3.0
NE	1.6%	2.9
ENE	1.6%	3.4
E	2.0%	2.8
ESE	3.4%	3.1
SE	8.0%	4.3
SSE	**14.4%****	**4.8**
S	**12.3%**	**3.4**
SSW	4.5%	2.2
SW	3.1%	1.9
WSW	2.1%	1.6
W	2.1%	1.4
WNW	3.1%	1.6
NW	7.6%	3.1
NNW	**9.5%**	**4.1**

Notes:
* Average based on a 10-year period
**Bolded values represent highest percentages and speeds

4.4.2 Selection of Outdoor Ambient Air Sampling Station Locations

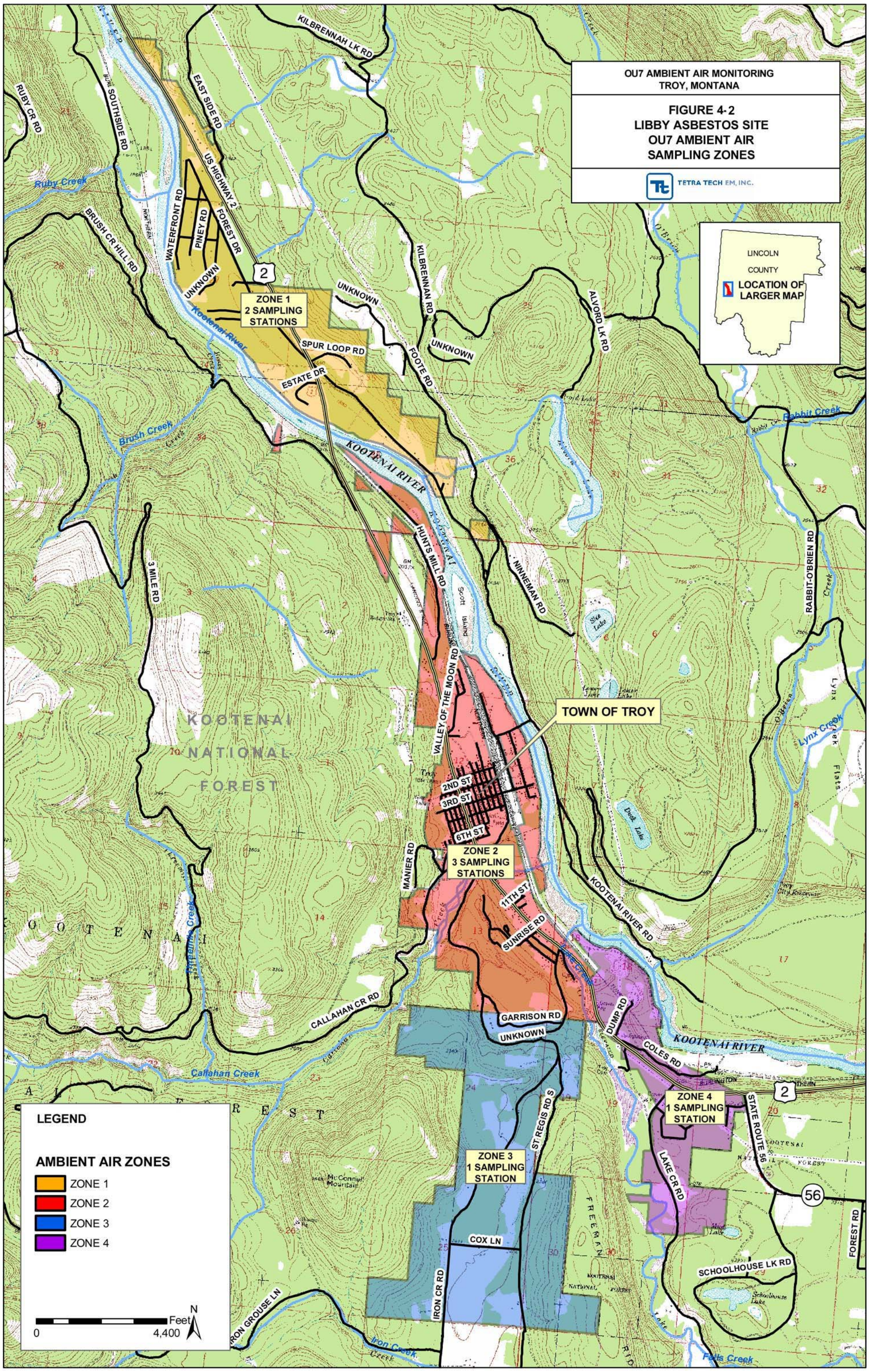
Outdoor ambient air sampling will be conducted at seven locations within four distinct outdoor ambient air sampling zones of OU7 (Figure 4-2). At present, the four air sampling zones have been defined based on geographic location and land use coverage.

As previously discussed, the predominant winds in Troy tend to flow in southeast and northwest directions, following the river corridor in which Troy is located. Two sampling stations (one each) will be placed in close proximity to the northwest and southeast boundaries of OU7. This will ensure that there are upwind and downwind sample collection stations for both directions the wind is blowing. Two stations (one each) will also be located on the northwest and southeast borders of downtown Troy in order to have upwind and downwind sample stations in the area with the highest population density. One sample station will be placed at the DEQ Troy Information Center in downtown Troy to measure LA concentrations in Troy. One station will be placed in the Kootenai Vista area in the northern portion of OU7 and the last station will be placed along or near Iron Creek Road in the southwestern portion of OU7.

Final locations for the seven air sampling stations will be determined prior to sampling and will be based upon access, landowner approval, and site security. Table 4-2 provides the proposed general locations and rationale for the seven stations. Proposed station locations are established to help ensure that the stations will provide adequate spatial coverage of the study area.

Once the sampling stations have been placed at each location, the global positioning system coordinates of each station will be recorded, and will be used to help in spatial pattern analysis and in the preparation of maps that summarize findings.

Meteorological data (wind speed, direction, temperature, humidity, and precipitation) will be collected from a portable weather station installed at the DEQ Troy Information Office facility. Although not considered necessary for the calculation of risk data, these data may be used to help evaluate and understand temporal patterns of outdoor ambient air results and sample representativeness if necessary.



GIS Map by Ed Madej TTEMI-HE
FIG4-1_TROY_AIR_ZONES_070909.MXD

TABLE 4-2

OUTDOOR AMBIENT AIR SAMPLING LOCATIONS

Station Number	Location*	Purpose
T1	Upwind/downwind site near the NW border of OU7	This site will be used to evaluate LA concentrations at the northern bounds of OU7 and confirm if any LA is entering or leaving OU7
T2	Community exposure site and middle bounds of OU7, located at the small community area NE of the Kootenai River	This site will be used to evaluate LA concentrations at the small community and the middle bounds of OU7
T3	City of Troy northern site	This site will be used to evaluate LA concentrations north of the Troy community
T4	City of Troy population exposure site	This site will be used to evaluate LA concentrations in the Troy community (specifically in the population center).
T4QC	City of Troy population exposure site	Co-located sample station of T4
T5	City of Troy southern site	This site will be used to evaluate LA concentration south of the Troy community
T6	SW upwind/downwind site	This site will be used to evaluate LA concentrations at the southwestern bounds of the OU and confirm if any LA is entering or leaving OU7
T7	SE upwind/downwind site	This site will be used to evaluate LA concentrations at the southeastern bounds of the OU and confirm if any LA is entering or leaving OU7

Notes:

LA	Libby Amphibole	SE	Southeast
NE	Northeast	SW	Southwest
NW	Northwest	OU	Operable Unit

* Predominant winds in the area blow from the southeast and northwest. Stations on the southeast and northwest bounds of OU7 will act as upwind and downwind receptors depending on wind direction. A summary of historic meteorological conditions is presented in Section 4.4.1.

4.4.3 Sample Station Set-Up

Outdoor ambient air samples will be collected and equipment calibrated based on EPA SOP 2015 (EPA 1994) for asbestos air sampling. EPA SOP 2015 is included as Appendix E to this document. According to SOP 2015, outdoor ambient air sampling pumps need to be placed near buildings. For the ambient air sampling in OU7, the pumps will be placed approximately 15 feet away from the southwestern and northeastern outer walls to reduce building interference with wind patterns and allow the samples to be exposed to the dominant northwest and southeast air patterns in the Troy valley. Sample locations will be chosen so that particulates generated by automobile traffic on dirt and gravel roads will be minimized.

Equipment shelters will be used to house the sampling pumps and batteries. The use of these shelters will protect the sampling equipment from adverse weather conditions that would otherwise interfere with the collection of year-round samples.

4.4.4 Collection Interval and Flow Rates

To ensure that target analytical sensitivities can be achieved, the target volume of air to be collected for each sample will be 21,600 liters. Tetra Tech may adjust this target volume based on changes in the target analytical sensitivities, sample results, or filter loading issues. A target volume of 21,600 liters will minimize the number of grid openings counted during laboratory analysis, reducing the time and cost of analysis while meeting the target analytical sensitivities.

The number of grid openings to be counted for this volume of air will be 45 and were calculated using the equation provided in Section 6.1 of SOP No EPA-LIBBY-09 (rev 1). This equation and the spreadsheet used to calculate them are shown in Appendix F.

To help ensure that samples capture long-term averages, each sample will be collected over a 5-day (120-hour) interval. Thus, the target flow rate is approximately 3 liters per minute over the entire sampling event to achieve the target volume of 21,600 liters.

4.4.5 Sampling Pumps

The pumps used for sampling will be SKC, Inc. AirCheck2000 or an equivalent pump. The pumps will be battery powered, with secondary battery backups in case of primary battery failure.

4.4.6 Sampling Schedule

At each station, sampling will occur on a regular 10-day schedule (5 days on and 5 days off). This will result in the collection of 36 field samples per year, per station. Sample collection at each station will be programmed to begin at the same time on a predetermined day of the week. During the first two sample collection events, every sampling station will be checked for visible loading and pump flow rate once a day during typical daytime work hours. If visible loading is observed on a filter, or if decreased flow is noted due to filter overloading, the collection of that sample cassette will be concluded. The duration of collection will be noted and a new cassette will be installed for the remainder of the sampling event. Both cassettes will then be submitted for analysis and the results will be totaled. This will maintain comparability for all sites since the sample duration will remain at 5 days. Tetra Tech may increase or decrease the frequency of inspections based on pump and filter performance.

Samples will be collected continuously during the 5-day (120-hour) sampling event until the target sample volume is reached. The pump will be programmed to download and store flow data on a regular interval, at least once every hour. The AirCheck2000 pumps will be programmed to shut off after the target volume is reached. When target volumes are reached, samples will be retrieved and prepared for shipment to the laboratory.

After a five day sampling event is completed, sample locations will then remain idle for five days. This monitoring schedule will provide the necessary information to complete assessments and statistical evaluations of LA dispersion across the entirety of OU7.

Sampling may be suspended if adverse weather conditions occur (e.g., precipitation that could interfere with sample viability and/or equipment function), or if there are hazardous winter road conditions. If a suspension of sampling occurs, the DEQ will be notified immediately. It is anticipated that due to the use of the equipment shelters, sampling will only be affected by extreme icing conditions or poor winter road conditions.

4.4.7 Filter Type – Pore Size

Samples will be collected using 25-millimeter diameter, 0.45 µm pore size, as specified in EPA SOP 2015. This pore size selection is also based on what was previously used in OU4 for outdoor ambient air sampling. This pore size allowed for the collection of samples with relatively high flow rates (and hence relatively large volumes) without excessive backpressure.

4.4.8 Sample Height

Studies in OU4 show no statistically significant difference in concentrations between samples collected at an adult's breathing height and a child's breathing height (CDM 2006). Therefore, all samples will be collected from the height of an adult's breathing zone; approximately 5 feet above ground level by using adequate lengths of Tygon® tubing that reach from the sampling pump in the equipment shelter to a sampling stand designed to hold the air sampling cassette at desired heights. A rain and snow shield will be placed over the equipment to prevent moisture-related impacts to sampling results. Figure 4-1 shows the approximate setup of a proposed sampling station.

4.4.9 Sampling Pump Calibration

Tetra Tech will calibrate the pumps according to the manufacturer's instructions (based on final model chosen) prior to each sampling event to ensure proper flow rate. Pumps will be calibrated using a National Institute of Standards and Technology (NIST)-certified primary flow meter connected to the MCS sample cartridge. If the pump cannot be successfully calibrated using the NIST primary flow meter, the pump will be replaced and the new pump will be calibrated before sampling begins.

4.4.10 Duration of the Sampling Program Schedule

The full duration of the monitoring program cannot be specified with certainty at this time, but it is expected that the program will last for at least 1 year. Assuming that 36 samples per year are collected from each of seven stations in OU7, 252 outdoor ambient air field samples will be collected (not including QA/QC samples). This number is expected to provide a good characterization of both geo-spatial and temporal variability. Table 4-3 displays the total number of samples to be collected.

TABLE 4-3
SUMMARY OF SAMPLES TO BE COLLECTED

Sample Type	Sample Analysis	Number of Samples To Be Collected	Percentage of Total Samples
Field Samples	TEM	252	76%
Lot Blanks (QA)	TEM	6	2%
Field Blanks (QA)	TEM	36	11%
Co-Located Samples (QA)	TEM	36	11%
	Total	**330**	100%

4.4.11 Sample Packaging and Shipping

Samples will be securely packaged and delivered to the ESAT laboratory at the end of each 5-day sampling event. A custody seal will be placed so that both ends of each sampling cassette are covered by the seal. If an overnight delivery service is used to ship the samples, the samples will be secured for shipment in a rigid container with sufficient packing material to prevent dislodging the collected fibers. Vermiculite, shredded paper, or expanded polystyrene cannot be used as packing material. Plastic bubble wrap is an example of an acceptable packing material. A hard copy of the COC report will be prepared by Tetra Tech and will accompany each shipment of samples to the ESAT laboratory Additional information on sample management and COC procedures is found in Section 5.4.

4.4.12 Analytical Methods

The outdoor ambient air and QA/QC samples submitted to the ESAT laboratory will be analyzed for asbestos fibers using International Organization for Standardization Transmission Electron Microscopy (TEM) method 10312 along with project specific modifications. Many studies of asbestos from the Libby mine have been completed to identify the structural minerals and the varying chemical composition of LA. The ESAT laboratory will complete TEM analyses using the most current laboratory modifications to help characterize and identify the attributes of any LA particles collected from OU7 outdoor ambient air. Libby outdoor ambient air samples collected after February 23, 2007 were analyzed in accordance with Laboratory Modification 66 (LB-000066) to provide detailed information on the occurrence of sodium and potassium in LA particles. All asbestos structures detected with a length greater than or equal to 0.5 microns (µm) and an aspect ratio greater than or equal to 3:1 will be recorded. LA structures and other types of asbestos structures will be recorded separately. Concentrations of contamination in outdoor ambient air will be calculated using only LA structures since this is the contaminant of concern.

4.5 FIELD DOCUMENTATION

Field documentation to be generated during this sampling program includes the following: field sample data sheets (FSDS), photographs (if necessary), and sample custody documentation. The following sections describe the types of field documentation, as well as how field documents will be corrected if errors occur, and the process for documenting deviations from field procedures prescribed in this Work Plan. Records storage and retention and data management for this sampling program are discussed in more detail in Sections 5.0 and 6.0, respectively.

4.5.1 Field Sample Data Sheets

The field staff will be responsible for documenting sampling information from each sampling event on FSDS, which will be maintained for the duration of the project. Information will be manually recorded on the sheets for the duration of each sampling event. The sheets will provide an account of sampling at each station including sample start and finish dates, start and finish times, sample station identification number, sample identification number, pump number, pump fault, start and finish flow rates, total sample volume, and total sample time.

Tetra Tech will use the daily check portion of the FSDS to record date, time, sample station identification number, sample identification number, pump number, pump fault, flow rate, primary battery voltage, photographs taken (if any) and any unusual conditions at the sample location. The FSDS will include a section to interview the property owner at the end of each sampling event for information regarding any notable events during the sampling event such as abnormal weather or nearby dirt disturbances.

The FSDS may be generated from a database report so that most of the static information (sample station identification number, sample identification number, pump number) is already completed and field staff would only need to enter the variable data on the FSDS. An example of the FSDS is provided in Appendix G.

4.5.2 Photographic Documentation

Digital photographic documentation will be recorded for each sampling location at the first collection event and any time thereafter that the equipment is moved or damaged, if the surroundings change, or at any other time the field staff determine necessary. Multiple photographs may be required to document any circumstances that may impact sampling quality. Photographs will be documented in the logbook with the direction of the photograph, time of day, and other pertinent site features. The photographs will be numbered using the following file format:

T-#_PhotoYYYYMMDD_#.jpg

Where: T-# = station number
YYYYMMDD = date in the format of year (YYYY), month (MM), and day (DD)
_# = picture number

4.5.3 Sample Labeling and Identification

Samples will be labeled with unique identification numbers supplied by the Data Manager, and will be signed out by the field staff (i.e., controlled). One sample label will be placed on the sampling cassette. The sample identification number will also be written on the outside of the plastic bag used to hold the sampling cassette during transport.

Sample identification numbers will identify the samples collected during the outdoor ambient air study and use the following format:

TA- #####

Where:	TA =	Troy Outdoor Ambient Air
	##### =	a sequential five digit number (unique)

4.5.4 Corrections to and Deviations from Documentation

FSDS modifications should include a single strikeout, initials of the field staff member recording the modification, and the date of documentation changes. The correct information should be entered in close proximity to the erroneous entry if possible. If errors are encountered after the field forms have been scanned, electronic comments will be attached to the portable document format (PDF) file using Adobe Acrobat explaining or clarifying the erroneous entry. All temporary or permanent deviations from the procedures and guidance information outlined in this Work Plan will be recorded on a Troy Record of Modification form. See Section 5.6 for further discussion of Record of Modification forms.

5.0 FIELD QUALITY CONTROL PROCEDURES

Section 5.0 describes the methods and procedures for decontamination, quality control samples, investigation-derived wastes, and maintaining sample records and COC.

5.1 EQUIPMENT AND PERSONNEL DECONTAMINATION

Decontamination of field equipment used for assembly, station repair or necessary maintenance (e.g. during maintenance or replacement of sampling pumps or enclosures) will be done in the location where the sample station is located, and will include wiping the equipment with pre-moistened cleaning wipes or spraying the equipment (as appropriate) with distilled water, and drying it with paper towels. The water will be allowed to fall on the ground in the area of the sampler, and the paper towels or cleaning wipes will be placed in a labeled asbestos waste bag for disposal.

Visible soil on hands or clothing will be removed by washing with soap and water. Additional personnel decontamination procedures, including requirements for decontamination zones, are described in Section 9.2 of the Tetra Tech HASP and amendment (Appendix A). Prior to achieving a successful negative exposure assessment, PPE will include disposable gloves, disposable protective outerwear, work boots, disposable boot covers, and respirators. Upon completion of a negative exposure assessment, PPE can be reduced to Level D for the remaining outdoor ambient air sampling project. The respirators will be cleaned and decontaminated as discussed in the HASP (Appendix A).

5.2 QUALITY CONTROL SAMPLES

Detailed information on QC sample collection and frequency is prescribed in the site-wide QAPP (CDM 2007). Three types of QA/QC samples will be collected as part of this investigation to include: lot blanks, field blanks, and co-located samples. All QA/QC samples will be submitted "blind" using unique sample identification numbers similar to those of real field samples. The total number and type of anticipated QC samples is describe below and shown in Table 4-3.

Lot blanks – Before any cassette is used, a cassette from each filter lot will be randomly selected and submitted for analysis. The lot blanks will be analyzed for asbestos fibers by the same method used for field sample analysis. The entire batch of cassettes will be rejected if any asbestos fiber is detected on a lot blank.

Field blanks – One field blank will be collected per 5-day sampling event for the duration of this sampling program. The field blanks will be analyzed for asbestos fibers by the same TEM method used for field sample analysis. The field blanks will be collected by opening the sample cassette package and exposing the cassette to the full range of field efforts including sample handling, car travel, 10 seconds attached to the air sample pump (not turned on), sample cassette retrieval, return to office, packaging, and transport to the laboratory.

Co-located samples – Co-located samples are used to determine the variability of the measured parameter. Because co-located outdoor ambient air samples are expected to be very nearly identical in true concentration, a comparison of the results between the two samples will be interpreted primarily as a reflection of the variability in the analytical method, which includes random Poisson variation in the number of structures observed. The two results will be compared using an appropriate statistical test for the comparison of two Poisson rates, and the samples will be considered concordant if the rates are not statistically different (Appendix F).

One co-located sample will be collected per sampling event for the duration of this sampling program (at least 36 per year). The co-located samples will be collected beside a field sample and will be given a unique sample identification number. Field co-located samples will be collected from the same location throughout the project and will consist of a co-located sampling station (Station Number T4QC) to be built approximately seven feet from the proposed sampling station to be located at the DEQ Troy Information Center. The field staff will assign different location IDs to the co-located sample and the field sample, and will record the identification number and type of each sample on the FSDS in the comments section. All co-located samples will be handled and sent for analysis using the same method as field samples.

Tetra Tech QA staff will perform an evaluation of the results from co-located samples according to criteria shown in Table 5-1 and based on concordance rates established for by EPA (EPA 2007) for re-preparation samples.

TABLE 5-1
CONCORDANCE RATES FOR CO-LOCATED SAMPLES

Overall Concordance Rate	Evaluation
> 95 percent	Good
90 to 95 percent	Acceptable
< 90 percent	Poor

If, after the collection of a minimum of 10 co-located samples, the overall concordance rate for co-located samples drops below 90 percent, DEQ will investigate (with assistance from Tetra Tech QA staff) the basis for the discrepancy and take corrective action in sampling and/or analysis of the samples, as appropriate.

5.3 CONTAINMENT AND DISPOSAL OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste will include the following used items: wet wipes, wet paper towels, disposable gloves, respirator cartridges, disposable plastic tubing, disposable protective outerwear, plastic floor coverings (from sampling station decontamination), and other minimal waste. Only small amounts of tubing will be used during calibration and to replace and repair any defective or worn tubing. It is possible, but not likely, that these investigation-derived waste materials may contain asbestos. Therefore, all investigation-derived waste will be double-bagged in appropriate asbestos bags, labeled with asbestos labels, and stored in an approved containment area at the DEQ Troy Information Center field office until it can be properly disposed of at an approved landfill (Lincoln County Landfill, outside of Libby). Non-

sampling waste generated by the field staff, such as food containers and waste paper, will be separately bagged and properly disposed of as solid waste.

5.4 SAMPLE CUSTODY AND SHIPPING

Tetra Tech sample team members will place a custody seal on each sample as described in Section 4.4.11. A sample storage bin will be used to transport the OU7 outdoor air samples back to the DEQ Troy Information Center field office. Care will be taken to handle and transport samples as little as possible so as to minimize excess vibration and potential for dislodging of fibers from the filter material. Any temporary storage of the samples will be in storage bins in a secured (locked) area at the field office. All samples collected from OU7, including QC samples, will be transferred to the ESAT laboratory at the end of each 5-day sampling event.

COC procedures will be implemented to handle all OU7 outdoor ambient air samples. The Tetra Tech field sample coordinator will prepare a hard copy of the COC report and the Tetra Tech field staff member will print the report and store it with the OU7 outdoor ambient air samples. The COC report will be transferred to the ESAT laboratory when the samples are shipped at the end of each 5-day sampling event. The COC record is the physical evidence of sample custody and control. This record system provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting.

5.5 RECORD KEEPING

An individual file (both paper and electronic) will be maintained for each air sampling station. Originals of all field forms will be kept in each individual air sampling station file in the DEQ Troy Information Center office for the duration of the project, so that information is available if questions arise. Scanned PDF copies of all field forms will be stored in electronic files (electronic data archive) for each sampling station. Additional information on the electronic data archive is provided in Section 6.1. In addition to field forms, signed and released copies of COC forms from ESAT will be stored in the DEQ Troy Information Center office. A backup electronic copy of the OU7 outdoor ambient air sample database and individual electronic air sampling station files will be stored in the Tetra Tech office in Helena, Montana, and updated periodically for the duration of the sampling, and reporting phases of the project. Copies of all QA/QC records and field forms will be available, on request, to DEQ and EPA at any time during the project.

5.6 MODIFICATIONS

The Tetra Tech Project Manager will continually monitor the field procedures to ensure that the objectives of the OU7 outdoor ambient air sampling program are accomplished. There may be circumstances where modification of the procedures described in this Work Plan is necessary to complete project objectives. The DEQ Project Officer, Tetra Tech Project Manager, or Tetra Tech field staff may request modifications to the approved procedures. All modifications will be documented on a Troy Record of Modification form prior to completion of the work. An example Troy Record of Modification form is provided in Appendix I. If the modification impacts are minimal, the field staff will complete the Troy Record of Modification form for approval by either the Field Staff Manager or DEQ Project Officer. If a project-wide modification is necessary, the DEQ project manager will complete the Troy Record of Modification form and then consult with the EPA Remedial Project Manager for approval. The Tetra Tech Project Manager or field staff member will not implement the modification until verbal or written approval is granted by the DEQ Project Officer. If verbal approval is provided, the Tetra Tech Project Manager or field staff member will note on the modification form when the approval occurred and the DEQ Project Officer will sign the approval form at the earliest available time. All Troy Record of Modification forms will be housed in the DEQ Troy Information Center office.

6.0 DATA MANAGEMENT

Management of the OU7 outdoor ambient air data will be under the guidance and supervision of the Tetra Tech Data Manager. The following sections describe the electronic data archive, project databases, and data entry procedures.

6.1 ELECTRONIC DATA ARCHIVE

As stated previously, data will be manually recorded on FSDS at the beginning and end of every sampling event, as well as periodic daily checks to ensure sample accuracy. Field staff will manage the FSDS and will scan them (to PDF file) on a weekly basis for submittal to the electronic data archive. Field staff will also download digital photographs to a computer at the DEQ Troy Information Center field office and stored in the electronic data archive. Photographs will be labeled as outlined in Section 4.5.2. The electronic data archive will consist of an individual electronic folder for each sampling station. Scanned access agreements, FSDS, digital photographs, and any other documentation pertinent to the outdoor ambient air program will be placed in the electronic data archive. The electronic archive will serve as a backup to the hard copy files maintained in the DEQ Troy Information Center office.

Table 6-1 shows the proposed file architecture for the electronic data archive (more data elements will be added as needed). A backup electronic copy of the OU7 outdoor ambient air electronic data archive will be stored in the Tetra Tech office in Helena, Montana, and updated periodically for the duration of the sampling and reporting phases of the project.

TABLE 6-1
EXAMPLE FILE ARCHITECTURE

Data Element	Example File Name
Directory Name	T-#
FSDS	T-#_FSDSYYYYMMDD.pdf
Photographs	T-#_PhotoYYYYMMDD_#.jpg

Note:
T-# = station number,
YYYYMMDD = date in the format of year (YYYY), month (MM), and day (DD)
_# = picture number

6.2 SCRIBE DATABASES

OU7 outdoor ambient air data will be managed using a Scribe database in accordance with EPA's Data Reporting Requirements for the Libby Asbestos Superfund Site (Appendix J). All entries in the Scribe database will conform to the formatting constraints and valid values that are specified in the EPA's Data Reporting Requirements. Scribe is a database application that was developed by the EPA's Environmental Response Team to manage environmental data. It was designed to capture sampling, observational, and monitoring data and is capable of importing electronic data including analytical laboratory results and sampling location data such as GPS coordinates. Detailed information and a downloadable version of the Scribe database application are available from the following website: http://www.ertsupport.org/scribe_home.htm.

6.2.1 Outdoor Ambient Air Scribe Projects

Three Scribe projects (also called Scribe databases) will be used to manage the OU7 outdoor ambient air data. The three Scribe projects are described below:

1) Sampling Project/Scribe Sample Database: This Scribe project will support field operations by managing station and associated sample information. These data will contain sample station data (including GPS coordinates), pump information, and detailed sample data.

The Scribe Sample Database will be used to manage outdoor ambient air sampling data that was downloaded from the pumps (if available) and verified by the FSDS. The database will also be used to generate the COC for each sampling event. Electronic copies of all COC for outdoor ambient air samples will be available in this Scribe database.

2) Analytical Project/Scribe Analytical Database: A second Scribe project will be used to manage analytical data. ESAT or the Data Manager will import electronic laboratory results into this Scribe database.

3) Combined Project/Scribe Combined Database: A third Scribe project will be used to manage the combined sample and analytical Scribe projects. In addition, this Scribe database will have custom queries that will be developed and maintained for OU7 outdoor ambient air.

All three datasets will be published to the internet as they are updated, or on a daily basis (if data has changed) using Scribe.net, whichever comes first. Subscribers to the Scribe.net final OU7 outdoor ambient air project will be able to download a complete database that contains all station, sample, analytical, and custom queries.

A Microsoft Access database may be developed for custom queries and reports. This OU7 outdoor ambient air report database will link to the final, Scribe Combined Database, and will enable users to generate reports and queries as needed.

6.2.2 Data Entry Procedures

Data entry procedures will be dependent on sample pump capabilities. If the pump is computer compatible, then pump data will be imported into the Scribe Sample Database. If the pump is not computer compatible, then the field staff will manually enter data into the Scribe Sample Database. Sampling data will be uploaded into the Scribe Sample Database at the end of each sampling event.

6.2.2.1 Computer Compatible Air Sampling Pump

The SKC, Inc. AirCheck2000 is a programmable electronic pump that can be connected to a computer for programming, sampling event datalogging and electronic transfer of data at the end of each sampling event. Each pump will be programmed prior to each sampling event and removed at the completion of each sampling event and transported to the DEQ Troy Information Center field office for data processing. The pertinent sample data from each pump will be downloaded by field staff into the Scribe Sample Database, or to a temporary Microsoft Access import database that will be used for pre-processing the pump data before importing data into Scribe. The Tetra Tech Data Manager will be responsible for creating the import database, writing instructions for the data import process, and generating any queries or reports that are needed to verify the data. The field staff will review the data for accuracy before the

data is publishing to Scribe by the Field Sample Coordinator. Part of the data review process will include checking the FSDS against the data downloaded from the pump.

If data cannot be downloaded from the SKC, Inc. AirCheck2000 (or equivalent) pump, then the field staff will follow the non-computer compatible pump directions in Section 6.2.2.2.

After the data have been successfully downloaded and Scribe data have been published to the internet, the air sampling pumps will be cleared of the sample event data and programmed for the next sample event.

6.2.2.2 Non-Computer Compatible Air Sampling Pump

The FSDS will be completed for each station at the beginning and end of each sample event. Pertinent sample data from the FSDS will be manually entered into Scribe by field or data management staff at the end of each sampling event. Data entry will be accomplished either by using the Scribe user interface or a custom form that is specific to the OU7 outdoor ambient air FSDS. Table 6.2 shows data that will be recorded with each sample event along with the associated EPA Data Reporting Elements.

TABLE 6-2
EPA DATA REPORTING ELEMENTS

OU7 Outdoor Ambient Air Data Fields	EPA Data Reporting Element – Table Name	EPA Data Reporting Element – Field Name
Start date	Samples	SampleStartDate
Start time	Samples	SampleStartTime
Stop date	Samples	SampleEndDate
Stop time	Samples	SampleEndTime
Sample station identification number	Samples	LocationID
Sample identification number	Samples	SampleID
Sample type	Samples	SampleType
Sample parent identification number	Samples	SampleParentID
Field technician	SurveyResult	
Filter identification number	SurveyResult	
Pump type/model	SurveyResult	
Pump number	SurveyResult	
Pump fault	SurveyResult	
Timer beginning time	SurveyResult	
Timer ending time	SurveyResult	
Start flow rate	SurveyResult	
Stop flow rate	SurveyResult	
Total sample volume	Samples	SampleVolume
Total sample time	SurveyResult	
Atmospheric pressure	SurveyResult	
Temperature inside station	SurveyResult	
Battery voltage reading	SurveyResult	
Comments	Samples	SampleComments

After the data have been entered into Scribe, a different staff member will generate a data verification report to ensure accurate data entry. The data verification report will be developed by the Tetra Tech Data Manager and will allow field staff to easily view sample data from the database. The data verifier will compare the data in the database against the FSDS. If a discrepancy is discovered, the data will be corrected along with proper documentation for the change.

7.0 QA/QC PROCEDURES

The sections below outline the project QA/QC objectives, internal field quality control check, audits and corrective actions, and data review and verification. Field QC procedures are described in Section 5.0. All QA/QC procedures are consistent with the site-wide QAPP (CDM 2007).

7.1 QA/QC OBJECTIVES

The primary QA/QC objective for the project is to obtain 100 percent usable and accurate data. This objective will be achieved through auditing sampling and field operations and COC procedures, and analyzing field and laboratory quality control samples.

7.2 INTERNAL QUALITY CONTROL CHECKS

Tetra Tech will conduct a thorough quality review of laboratory analytical data. Tetra Tech will review data from both laboratory QC samples described below, and field QC samples described in Section 5.2. Tetra Tech will follow standard protocols outlined in the SOP No. EPA-LIBBY-09 (rev 1) for validation of outdoor ambient air samples analyzed for asbestos by TEM. The SOP is provided in Appendix F.

The ESAT laboratory will analyze all samples following Libby Asbestos Superfund Site protocols, including EPA's most recent protocols relating to QA/QC for the Libby Asbestos Superfund Site. As such, the QA/QC protocols followed by the ESAT laboratory are not within Tetra Tech's immediate control. All ESAT laboratory data will be compatible with and can be loaded directly into a Scribe database.

7.3 AUDITS, CORRECTIVE ACTIONS, AND QA REPORTS

Field audits will be an integral part of Tetra Tech's field operations for the duration of the outdoor ambient air sampling program. Field audits and corrective actions will be the responsibility of the Tetra Tech Field Team Manager. The field audit forms will be stored in the DEQ Troy Information Center office for the duration of the project. An example field audit form is provided in Appendix H.

7.3.1 Field Inspections and Sampling Procedures Audits

The Tetra Tech Field Team Manager will be responsible for audits of outdoor ambient air sampling procedures. Audits will be conducted quarterly for the duration of the sampling effort. Audits will consist of the Field Team Manager or his designee attending a sampling event and observing the activities of the field staff (air technician). The field staff will not be warned of the audit. The auditor will compare the field staff's activities with the protocols provided in this Work Plan and the attached project-specific guidance, and will evaluate compliance with the protocols using the audit checklist form. A copy of the audit checklist form is provided in Appendix H. After the audit, the auditor will provide the completed audit form to the DEQ and Tetra Tech Project Manager. Completed copies of audit checklist forms will be scanned and saved in the electronic data archive; hard copies will be retained in the DEQ Troy Information Center office.

7.3.2 Corrective Action Procedures

If the Tetra Tech Field Team Manager identifies deficiencies during the audit, he or she may use his/her discretion to provide immediate verbal feedback to the field staff, to ensure that deficiencies are corrected as quickly as possible. The Tetra Tech Field Team Manager will also review the audit report with the field staff within 48 hours of the audit to ensure that deviations or deficiencies are corrected. The field staff will be audited again during the next scheduled sampling event to ensure that deficiencies have been corrected. If a field staff member is rotated off the project after deviations or deficiencies were noted, the new and remaining field staff members will be audited again during the next scheduled sampling event. If gross deficiencies are noted, the Tetra Tech Field Team Manager will consult with the DEQ Project Officer to determine if re-sampling or other actions as appropriate may be required.

7.4 TEM DATA REVIEW AND DATA ENTRY VERIFICATION

Tetra Tech will conduct data review and data entry verification of the outdoor ambient air TEM data in accordance with standard operating procedure (SOP) EPA-LIBBY-09 (rev 1). The SOP describes a standardized method for review of raw TEM data and verification of TEM data entry into the project database. Libby-specific procedures described in this SOP will be modified, as needed, for the OU7 Outdoor Ambient Air project. A copy of this SOP is provided in Appendix F.

Tetra Tech's review and verification process entails three steps: (1) the selection of data records for review and verification, (2) a review of the original laboratory bench sheets, and (3) verification of the transfer of results from the bench sheets into the OU7 Ambient Air Scribe Database.

7.4.1 Selection of TEM Records for Review

To ensure that a representative subset of ambient air TEM results are reviewed and verified, Tetra Tech will follow the record selection process in Section 4.0 of SOP EPA-LIBBY-09 (rev 1) (Appendix F); modified as needed for OU7. A minimum of 10 percent of the TEM ambient air sample results will be selected for review and verification. These will be selected through a query of the OU7 Ambient Air Scribe Database. The query will be designed to randomly select a representative number of results by laboratory analyst as well as result type (detected/nondetected).

7.4.2 Consistency Review of Laboratory Bench Sheets

Tetra Tech will inspect the information recorded on the original hand-written laboratory bench sheets in accordance with the consistency review of laboratory bench sheets procedure outlined in Section 5 of SOP EPA-LIBBY-09 (rev 1) (Appendix F); modified as needed for OU7. Scanned copies of the original hand-written bench sheets will be reviewed by Tetra Tech to inspect the data entered and identify the occurrence of any data omissions, apparent inconsistencies, or potential errors in structure.

Corrective Action - Tetra Tech will summarize all apparent inconsistencies, omissions, or other suspected errors and provide them to the laboratory liaison, who will forward them to the appropriate labs for response. The ESAT laboratory will determine which items are authentic errors that require correction and correct the electronic data deliverable (EDD) and/or bench sheets as needed. The revised bench sheets will be submitted to the laboratory liaison. Tetra Tech will download the revised documents, review them, and replace the previous ones as appropriate.

7.4.3 Verification of Data Transfer from Bench Sheet to Database

To ensure that data from laboratory bench sheets were transferred into the OU7 Ambient Air Scribe Database without error or omission, Tetra Tech will compare the analysis-specific information in the database to that on the laboratory bench sheets and EDD sheets. Tetra Tech will follow the verification of data transfer procedure outlined in Section 6.0 of SOP EPA-LIBBY-09 (rev 1) (Appendix F) and modified it as needed for OU7. The bench sheets include the laboratory COC form, sample check-in form, preparation log, and data record sheets.

Corrective Action - Tetra Tech will summarize all apparent inconsistencies, omissions, or other suspected errors and provide them to the laboratory liaison, who will forward them to the appropriate labs for response. The ESAT laboratory will determine which items are authentic errors that require correction and correct the EDD and/or bench sheets as needed. The revised bench sheets will be submitted to the laboratory liaison. Tetra Tech will download the revised documents, review them, and replace the previous ones as appropriate.

REFERENCES

Camp Dresser & McKee (CDM). 2002. Final Sampling and Analysis Plan, Contaminant Screening Study, Libby Asbestos Site. April.

CDM. 2003a. Final Sampling and Analysis Plan, Remedial Investigation, Contaminant Screening Study, Revision 1. April.

CDM. 2003b. Final Sampling and Analysis Plan, Remedial Investigation, Libby Asbestos Site. May.

CDM. 2006. Site Specific Standard Operating Procedure, Collection of Outdoor Ambient Air Samples. December.

CDM. 2007. Draft Quality Assurance Project Plan, Libby Asbestos Site, Libby, Montana, January 2007.

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. John Wiley & Sons, Inc., New York, NY.

Haas, C.N., Rose, J.B., and C.P. Gerba. 1999. *Quantitative Microbial Risk Assessment*. John Wiley and Sons, New York, NY.

Helsel, D.R. 2005. *Nondetects and Data Analysis*. Statistics for Censored Environmental Data. John Wiley and Sons, Inc. Hoboken, NJ. 250 p.

Land, C.E. 1975. "Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance." In *Selected Tables in Mathematic Statistics, Vol. III*. American Mathematical Society, Providence, R.I.

Tetra Tech EM Inc. (Tetra Tech). 2007. Troy Asbestos Property Evaluation Work Plan (Field Sampling Plan and Quality Assurance Project Plan). July 9.

U.S. Environmental Protection Agency (EPA). 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. Intermittent Bulletin, Volume 1, Number 1. Publication 9285.7-081.

EPA. 1994. "Asbestos Sampling, Standard Operating Procedure #2015, Revision 0.0. November.

EPA. 2000a. "Data Quality Objectives Process for Hazardous Waste Site Investigations (EPA QA/G-4HW)." Office of Environmental Information. Washington, D.C. EPA/600/R-00/007. January.

EPA. 2003b. Libby Asbestos Site Residential/Commercial Cleanup Action Level and Clearance Criteria, Technical Memorandum. Draft Final. Prepared by US EPA with Technical Assistance from: Syracuse Research Corporation. December 15.

EPA. 2005. Region 8 Background Factsheet, Libby Asbestos. Date accessed: July 5, 2005. Online address: http://www.epa.gov/region8/superfund/libby/index.html.

EPA 2006a. "Guidance on Systematic Planning Using the Data Quality Objectives Process". EPA QA/G-4." Office of Environmental Information. Washington, DC. EPA/240/B-06/001. February.

EPA. 2006b. "Final – Revision 1, Sampling and Analysis Plan for Outdoor Ambient Air Monitoring at the Libby Asbestos Site, Operable Unit 4, Libby, Montana." Region 8, Denver, Co. December.

EPA. 2007. "Summary Report for Data Collected Under the Supplemental Remedial Investigation Quality Assurance Project Plan (SQAPP). Prepared by: EPA Region 8 with Technical Assistance from Syracuse Research Corporation, Denver, CO. October 23.

EPA 2008. "Standard Operating Procedure for TEM Data Review and Data Entry Verification". SOP-LIBBY-09 (rev 1). Woodbury, Lynn. Syracuse Research Corporation. March 5.

EPA. 2009a. "ProUCL Version 4.00.04 Technical Guide (Draft)." Prepared by Singh, A. and A.K. Singh. EPA/600/R-07/041. February.

EPA. 2009b. "ProUCL Version 4.00.02 User Guide (Draft)." Singh, A., Maichle, R., Singh, A.K., Lee, S.E., and N. Armbya. Office of Research and Development, National Exposure Research Laboratory, EPA/600/R-07/038. February.

U.S. Geological Survey (USGS). 2005. Reconnaissance Study of the Geology of U.S. Vermiculite Deposits - Are Asbestos Minerals Common Constituents? USGS Survey Bulletin 2192.

APPENDIX A

TROY ASBESTOS PROPERTY EVALUATION (TAPE) SITE-SPECIFIC HEALTH AND SAFETY PLAN
AND
SITE-SPECIFIC HEALTH AND SAFETY PLAN AMENDMENT

(See Attached CD)

Health and Safety Plan

for

Troy Asbestos Property Evaluation (TAPE)

HEALTH AND SAFETY PLAN

Troy Asbestos Property Evaluation

	Contract No.	:	DEQ 402014-TO41
		:	
Date	Prepared	:	5/18/09
	Prepared by	:	Tetra Tech EM Inc. (Tetra Tech)
Date	Reviewed	:	5/27/09
	Reviewed by	:	Denny Cox
	Tech Project Manager	:	J. Edward Surbrugg, Ph.D.
	Telephone No.	:	(406) 442-5588

REVIEWS AND APPROVALS

CLIENT NAME: Montana Department of Environmental Quality
CONTRACT NO.: DEQ 402014-TO41

We the undersigned have read and approve of the health and safety guidelines presented in this health and safety plan for on-site work activities for the Troy Asbestos Property Evaluation project.

Name	Signature	Date
Denny Cox, Central Region Safety Officer Tetra Tech EM Inc. (Tetra Tech) Health and Safety Representative		
J. Edward Surbrugg, Ph.D. Tetra Tech Project Manager		

This certifies that Tetra Tech has assessed the type, risk level, and severity of hazards for the project and has selected appropriate personal protective equipment for site personnel in accordance with Occupational Safety and Health Administration Title 29 of the *Code of Federal Regulations*, Part 1910.132.

Certified by

Denny Cox, Central Region Safety Officer Tetra Tech Technical Reviewer		

EMERGENCY INFORMATION
EMERGENCY CONTACTS AND ROUTE TO HOSPITAL

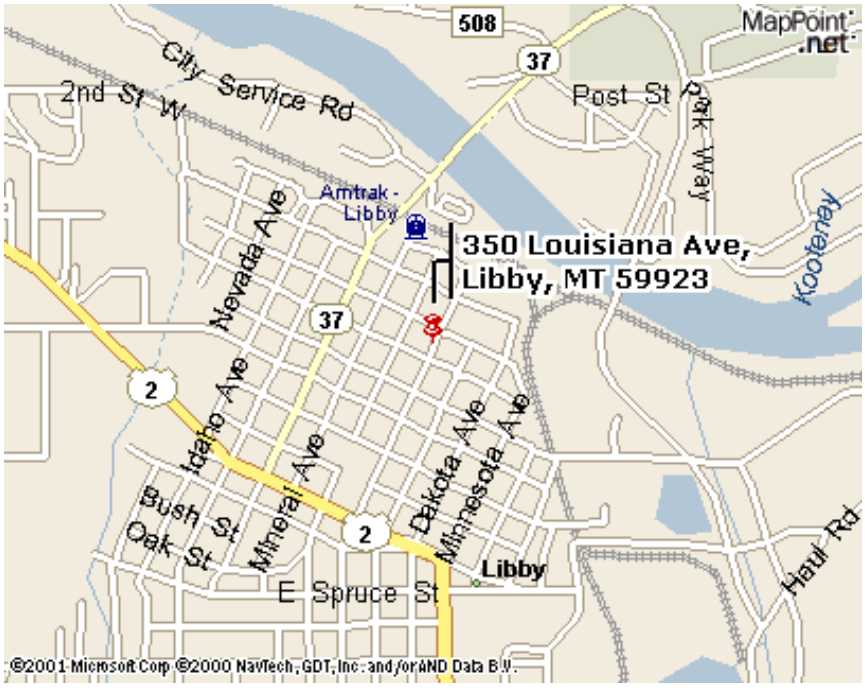
Emergency Contact	**Telephone No.**
U.S. Coast Guard National Response Center	(800) 424-8802
Montana Department of Emergency Services	(406) 431-0411
InfoTrac Chemical Monitoring System	(800) 535-5053
Fire Department	911
Police Department	911
Tetra Tech EM Inc. Personnel:	
Human Resource Development: Amy Clark	(626) 351-4664
Regional Health and Safety Officer: Denny Cox	(816) 668-7464
Project Manager: J. Edward Surbrugg	(406) 442-5588, ext. 230
Site Safety Coordinator: Mark Stockwell	(208) 263-4524
Alternate Site Safety Coordinators: Colin McCoy	(816) 225-4030
Steve MacNeill	(406) 442-5588
Client Contact: Catherine LeCours	(406) 841-5040
Client Title: Montana DEQ Project Officer	
Medical Emergency	
Hospital Name:	St. John's Lutheran Hospital
Hospital Address:	350 Louisiana Avenue Libby, MT 59923
Hospital Telephone No.: General – 406-293-0100	Emergency – 911
Ambulance Telephone No.:	911

Route to Hospital: (see next page, hospital route map)

1. Routes will differ from each sample site; however, the route from the main east/west highway (US-2) is as follows:
2. Follow Missouri Avenue (US-2) east for 17.0 miles to Libby, Montana
3. Turn left at California Avenue for 0.3 miles
4. Turn right at West 4th Street for 0.2 miles
5. Turn left at Louisiana Avenue for 161 feet.

Note: This sheet must be posted on site.

EMERGENCY INFORMATION
HOSPITAL ROUTE MAP



Note: This sheet must be posted on site.

EMERGENCY INFORMATION

EMERGENCY CONTACTS AND ROUTE TO HOSPITAL

Medical Emergency (secondary – use for major emergency only)	
Hospital Name:	St. John's Lutheran Hospital
Hospital Address:	350 Louisiana Avenue, Libby, MT 59923
Hospital Telephone No.:	Emergency – 911 or General – 406-293-0100
Ambulance Telephone No.:	911
Route to Hospital: (see next page hospital route map) 1. Routes will differ from each sample site; however, the route from the main east/west highway (US-2) is as follows: 2. Follow Missouri Avenue (US-2) east for 17.0 miles to Libby, Montana 3. Turn left at California Avenue for 0.3 miles 4. Turn right at West 4th Street for 0.2 miles 5. Turn left at Louisiana Avenue for 161 feet..	

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1.0 INTRODUCTION

This document addresses items specified under Occupational Safety and Health Administration (OSHA) Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.120 (b), "Final Rule," and 29 CFR 1910.1001. This health and safety plan (HASP) will be available to all on-site personnel who may be exposed to hazardous on-site conditions, including Tetra Tech EM Inc. (Tetra Tech) and subcontractor personnel, and all site visitors and regulatory agency representatives. The site-specific health and safety provisions in this document have been developed for use during the Troy Asbestos Property Evaluation (TAPE) inspection and sampling

This HASP defines requirements and designates protocols to be followed during the TAPE inspection and sampling. All personnel on site, including Tetra Tech and subcontractor employees and site visitors, must be informed of site emergency response procedures and any potential health or safety hazards associated with on-site activities. This HASP summarizes potential hazards and defines protective measures planned for activities at the site.

This plan must be reviewed and approved by the Tetra Tech health and safety representative (HSR), or a designee, and the Tetra Tech project manager (see the Reviews and Approvals form after the contents in this document). All personnel must sign the Compliance Agreement form in Appendix A before they enter the site. Protocols established in this HASP are based on site conditions and health and safety hazards known or anticipated to be present and on available site data. This plan is intended solely for use during proposed activities described in the corresponding site-specific work plan. Specifications are subject to review and revision based on actual conditions encountered in the field during site activities. The Tetra Tech project manager and the Tetra Tech HSR must approve significant revisions to this plan. Tetra Tech employees must also follow safety requirements taught during safety training and described in the Tetra Tech, Inc., "Health and Safety Manual" (1999).

2.0 HEALTH AND SAFETY PLAN ENFORCEMENT AND PERSONNEL

This section describes responsibilities of project personnel, summarizes requirements for subcontractors and visitors who wish to enter the site during the survey and sampling, and discusses HASP enforcement.

2.1 PROJECT PERSONNEL

The following personnel and organizations are associated with planned activities at the site. The organizational structure will be reviewed and updated as necessary during the course of the project.

Name/Title	Responsibility	Telephone No.
Client Representative:		
Ms. Catherine LeCours	Montana Department of Environmental Quality (DEQ) Representative	(406) 841-5040
Tetra Tech Personnel:		
J. Edward Surbrugg	TAPE Project Manager	(406) 442-5588 x 230
Mark Stockwell	Site Safety Coordinator (SSC)	(208) 263-4524
Mark Stockwell	Field Team Manager	(208) 263-4524

The Tetra Tech project manager, contract manager, SSC, and field team leader will be responsible for implementation and enforcement of the provisions of this HASP, including completion of all applicable forms provided as appendices to this HASP. Their duties and the expectations for Tetra Tech employees are described in the following sections.

2.1.1 Project Manager and Field Team Manager

The Tetra Tech project manager has ultimate responsibility for implementing the requirements set forth in this HASP. Some of this responsibility may be achieved through delegation to site-dedicated personnel who report directly to the project manager. The project manager shall regularly confer with site personnel on compliance with safety and health requirements.

The Tetra Tech field team manager will oversee and direct field activities and has day-to-day responsibility for implementing the HASP. The field team manager will report any health and safety-related issues directly to the project manager.

2.1.2 Site Safety Coordinator

The Tetra Tech SSC will be appointed by the project manager and will be responsible for field implementation of tasks and procedures contained in this HASP, including air monitoring, establishing a decontamination protocol, and ensuring that all personnel working on site have signed the Daily Tailgate Safety Meeting form (Form HST-2) and the Compliance Agreement (Form HSP-4) (see Appendix A). The SSC will have advanced field work experience and be familiar with health and safety requirements specific to the project. The SSC will also maintain the Daily Site Log (Form SSC-1 in Appendix A).

2.1.3 Health and Safety Representative

The Tetra Tech HSR is responsible for administration of the company health and safety program. The HSR will act in an advisory capacity to project managers and site personnel for project-specific health and safety issues.

2.1.4 Tetra Tech Employees

Tetra Tech employees are expected to fully participate in implementing the site HASP by obtaining necessary training, attending site safety meetings, always wearing designated personal protective equipment (PPE), complying with site safety and health rules, and advising the Tetra Tech SSC of health and safety concerns at the site.

2.2 SUBCONTRACTORS

Subcontractors will follow and adhere to the same guidelines stated in Section 2.1.4, however they should provide their own health and safety documentation for the protection of their employees. Tetra Tech has prepared this HASP solely for the protection of Tetra Tech employees, and assumes no responsibility for the protection of others. Subcontractors must supply their own PPE, training, medical monitoring, and any other items necessary for compliance with State, OSHA and other pertinent regulations.

2.3 VISITORS

All site visitors will be required to read the HASP and sign the Compliance Agreement form (see Appendix A). Visitors will be expected to comply with relevant OSHA requirements. Visitors will also be expected to provide their own PPE as required by the HASP. Visitors who have not met OSHA

requirements for training, medical surveillance, and PPE are not permitted to enter areas where exposure to hazardous materials is possible.

2.4 HEALTH AND SAFETY PLAN ENFORCEMENT

This HASP applies to all site activities and all personnel working on the TAPE project. HASP enforcement shall be rigorous. Violators of the HASP will be verbally notified on first violation, and the Tetra Tech SSC will note the violation in a field logbook. On a second violation, the violator will be notified in writing, and the Tetra Tech project manager and the violator's supervisor will be notified. A third violation will result in a written notification and the violator's eviction from the site. The written notification will be sent to human resources development and the HSR.

Personnel will be encouraged to report to the SSC any conditions or practices that they consider detrimental to their health or safety or that they believe violate applicable health and safety standards. These reports may be made orally or in writing. Personnel who believe that an imminent danger threatens human health or the environment are obligated to remove themselves from the area or the hazardous condition and warn all other personnel of the source of the danger. The hazardous condition or matter will be brought to the immediate attention of the SSC for resolution.

At least one copy of this HASP will be available to all site personnel at all times. The SSC will discuss minor changes in HASP procedures at the beginning of each workday at the daily tailgate safety meeting. Significant plan revisions must be discussed with the HSR and project manager, and approved by the HSR.

3.0 SITE BACKGROUND

The TAPE inspection and sampling project will include collecting soil samples from private and public property to evaluate the magnitude and extent of asbestos contamination. The following sections describe the TAPE site, its history, and activities planned for this project. The location of Troy, Montana, is shown in Figure 1.

FIGURE 1 – SITE LOCATION

3.1 SITE DESCRIPTION

Troy, Montana, is located 18 miles from Libby, Montana. Through 1990, a vermiculite mine and associated processing operations in Libby produced a large amount of the world supply of vermiculite. The vermiculite deposit is contaminated with a form of amphibole asbestos (Libby amphibole). Asbestos is a known carcinogen and is associated with a multitude of respiratory health effects, including asbestosis, lung cancer, and mesothelioma. For decades, contaminated vermiculite and associated waste materials have been ubiquitous in the community while the mine operated and after its closure. Many of the mine workers lived in Troy and commuted to work at the mine. Workers were exposed to contaminated materials at the mine and processing facilities and transported contaminated dust to their homes on clothes and equipment. Vermiculite and contaminated waste rock in varying forms was used in soils (as fill or an amendment), construction materials, and for insulation in various locations in Troy.

In 1999, U.S. Environmental Protection Agency (EPA) Region 8 dispatched an emergency response team to investigate media reports that described a high rate of asbestos-related deaths in Libby. Originally believed to be a problem limited to the mine workers, the scope has recently increased. Subsequent environmental investigations have found many areas in Libby with Libby Amphibole (LA) contamination. EPA began Superfund emergency response removal actions in Libby in 2000 that are ongoing through 2009. Properties in Troy are being investigated to evaluate whether LA-contaminated vermiculite has been transported to these sites and if it exists at concentrations that would pose risks to human health.

3.2 PLANNED ACTIVITIES

Activities to be performed during the TAPE include the following:

Indoor Inspections: The two-person sampling team will visually inspect each structure for the presence of vermiculite-containing insulation (VCI).

Outdoor Inspection: All areas of a property that are not special use areas or covered with structures will be visually inspected for vermiculite product in soil and surfacing materials.

Outdoor Soil Sampling: While conducting the visual inspection of the property, the sampling team will collect soil samples. Soil samples will be collected at all properties, whether visual VCI or LA is observed or not.

Aggressive Attic Inspections: When attic access locations are limited and the entire space cannot be adequately inspected from the available access locations, a field technician will enter the attic with his/her full body to perform the necessary inspection and collect samples of any VCI present. This procedure is described in Appendix C.

4.0 EVALUATION OF SITE-SPECIFIC HAZARDS

Field activities and physical features of the site may expose field personnel to a variety of hazards. This section provides information on potential hazards related to site activities and the nature of effects from hazardous materials.

4.1 CHEMICAL HAZARDS

Tremolite-actinolite asbestos is the only potentially hazardous substance anticipated to be encountered during site activities. Potential routes of exposure, exposure limits, and the toxic characteristics of asbestos are listed in Table 4-1. The primary route of exposure is inhalation; however, secondary potential routes of exposure include dermal (skin) contact and ingestion. Asbestos may also contaminate equipment, vehicles, instruments, and personnel. The overall health threat to Tetra Tech employees from exposure to asbestos during this project is uncertain because: (1) actual concentrations that personnel could be exposed to cannot be predicted until assessments and sampling activities begin, (2) the actual duration of exposure is unknown, and (3) the effects of low-level exposure to a mixture of chemicals or asbestos cannot be predicted.

Specific information on potential chemical hazards at the site is provided in Table 4-1. Table 4-2 provides a task hazard analysis of the activities planned and listed in Section 3.2.

Tetra Tech will not bring any potentially hazardous materials to the site during the field activities. Because of the nature of asbestos sampling, all PPE and monitoring equipment can be decontaminated using soap and water. Air monitoring equipment to be used during this project will be calibrated without the use of hazardous materials.

TABLE 4-1

POTENTIAL CHEMICAL HAZARDS
TAPE INSPECTION AND SAMPLING PROJECT

Chemical	Exposure Limits and IDLH Level	Exposure Routes	Toxic Characteristics
Asbestos	OSHA PEL: 0.1 fiber/cm^3 (8 hour TWA) OSHA Excursion Limit: 1 fiber/ cm^3 (30 minute exposure) ACGIH TLV: 0.1 fiber/cm^3 NIOSH REL: 0.1 fiber/ cm^3 IDLH: Not Established	Inhalation (primary), ingestion, skin or eye contact	Lung cancer, mesothelioma, Asbestosis (chronic exposure): dyspnea (breathing difficulty), interstitial fibrosis, restricted pulmonary function, finger clubbing; eye irritation

Notes:

ACGIH	American Conference of Governmental Industrial Hygienists
IDLH	Immediately dangerous to life or health
cm^3	Cubic centimeter
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
ppm	Part per million
REL	Reference Exposure Level
TLV	Threshold limit value
TWA	Time weighted average

Sources: ACGIH. "Threshold Limit Values and Biological Exposure Indices for 1998." Latest edition.

National Institute for Occupational Safety and Health. 2004. "Pocket Guide to Chemical Hazards." U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. June.

TABLE 4-2

TASK HAZARD ANALYSIS
TAPE Inspection and Sampling Project

Task	Potential Hazard	Controls	Initial Level of Protection	Upgraded Level of Protection
Task 1 – Interior Attic Evaluations and air monitoring	Potential asbestos exposure. Physical hazards include confined space entry; and slips, trips, falls, overhead hazards, and heat related hazards. Risks associated with ladder use. Risks associated with falls between roof trusses.	Use of buddy system at all times, use of flashlights when necessary, hazard awareness. Inspections will be conducted to limit the potential for exposure. Performance of personal air monitoring at selected locations. Follow Safe Work Practices (SWP).	Level C protection when accessing all attic spaces. Initial use of PAPR respirators	Level C protection will be required when accessing all attic spaces
Task 2 – Exterior yard and open area inspections, and soil sampling	Potential asbestos exposure. Physical hazards include slips, trips, and falls.	Use of buddy system and hazard awareness. Follow SWPs including the use of PPE whenever LA is observed, proper decontamination procedures, physical and biological safety procedures, and emergency and communication procedures.	Level C protection until a negative exposure assessments NEA has been obtained. Level D protection for general soil sampling, although respirators will be required whenever LA or VCI is observed. Disposable booties will be required whenever sampling in loose soil or special use areas.	Potential for upgrade to level C protection may be necessary using P-100 cartridges. Full or ½ face respirator can be used. Decision to upgrade to be made by the SSC/field manager based on site conditions, monitoring results, and presence of friable asbestos.

Notes:
PAPR Powered Air Purifying Respirator
NEA Negative Exposure Assessments

The following steps will be taken to reduce the potential for inhaling asbestos:

- Personnel will avoid sampling methods and procedures that would cause nonfriable asbestos-containing material (ACM) to become friable, such as not wetting soils prior to sampling.
- The level of PPE shall be upgraded from level D to level C at any time that sampling conditions warrant, as determined by the SSC or field manager.

4.2 PHYSICAL AND BIOLOGICAL HAZARDS

Physical and biological hazards associated with site activities present a potential threat to on-site personnel. Dangers are posed by slippery surfaces, unseen obstacles, poor illumination, use of ladders, and low overhead clearance, as well as insects, Hantavirus, and hostile animals.

Injuries resulting from physical and biological hazards can be avoided by using safe work practices (SWP). To maintain a safe workplace, the SSC will conduct and document regular safety inspections and will make sure that all Tetra Tech workers and visitors are informed of any potential physical and biological hazards related to the site. Physical and biological hazards that have been identified at this site include the following:

- Spiders, including brown recluse and black widow
- Potential disease agents from animal/bird feces, including Hantavirus and Histoplasmosis
- Hostile domestic or stray animals, or building occupants
- Ladders and other equipment used to access attics and areas for sample collection
- Trips, slips, falls in yards and open areas
- Heat stress
- Cold stress
- Fall hazard (from ladders and through roof trusses in attics)
- Potential confined space entry – no permits are anticipated to be necessary for sampling, however, occupants will be asked to provide information on any known or potential hazards in basements, crawl spaces or other areas. If presence of hazards is confirmed by the occupant, Tetra Tech field team members will not enter those areas.

5.0 TRAINING REQUIREMENTS

All on-site personnel who may be exposed to hazardous conditions, including Tetra Tech and subcontractor personnel and site visitors who will participate in on-site activities, will be required to meet training requirements outlined in 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," And 29 CFR 1910.1001. In addition, all Tetra Tech personnel participating in aggressive attic inspections shall be trained as either an Asbestos Hazard Emergency Response Act (AHERA) contractor/supervisor or worker meeting the requirements of 29 CFR 1926.32 (f) and the EPA's Model Accreditation Plan (40 CFR 763). All personnel and visitors entering the site will be required to review this HASP and sign the Compliance Agreement form (HSP-4), and site workers will be required to sign the Daily Tailgate Safety Meeting form (HST-2) (see Appendix A).

Personnel collecting asbestos samples will, at a minimum, be 40-hour HAZWOPER trained, have current 8-hour HAZWOPER refresher training, be respiratory protection trained, asbestos awareness trained, and have a copy of these certificates on their person or on file in the DEQ Troy Information Center at all times they are on-site performing work. Additionally, a copy of a current respirator fit-test will be on-site for each employee performing work.

The field team will also received a training module on confined space issues during the site-specific health and safety training prior to beginning the survey. All staff will be trained on how to identify confined spaces, and what defines a permit required confined space. As some of the attic spaces and crawl spaces meet the traditional definition of a confined space, but will need to be inspected or sampled, Tetra Tech will restrict access to spaces smaller than 30-inches high and 10-by 10-feet in size. Tetra Tech will ventilate all crawl spaces and attics with a 600 cfm air filtration machine for at least 10 minutes prior to accessing excessively hot attics to provide cooling and fresh air intake. The air filtration unit will be activated once the access hatch to the crawl space or attic is opened and remain running until decontamination procedures are completed.

Before on-site activities begin, the Tetra Tech SSC will present a briefing for all personnel who will participate in on-site activities. The following topics will be addressed during the pre-work briefing:

- Names of the SSC and the designated alternate
- Site history

- Tasks
- Hazardous chemicals that may be encountered on site
- Physical hazards that may be encountered on site
- PPE, including type or types of respiratory protection to be used for work tasks
- Training requirements
- Action levels and situations requiring upgrade or downgrade of level of protection
- Site control measures, including site communications, and SWPs
- Decontamination procedures
- Confined space entry
- Aggressive attic entry procedures
- Emergency communication signals and codes
- Personnel exposure and accident emergency procedures (in case of falls, exposure to hazardous substances, and other hazardous situations)
- Emergency telephone numbers
- Emergency routes

Any other health and safety-related issues that may arise before on-site activities begin will also be discussed during the pre-work briefing.

Issues that arise during on-site activities will be addressed during tailgate safety meetings to be held daily before the workday or shift begins. The briefings will be documented on the Daily Tailgate Safety Meeting form (Form HST-2 in Appendix A). Any changes in procedures or site-specific health and safety-related matters will be addressed during these meetings.

6.0 PERSONAL PROTECTION REQUIREMENTS

The levels of PPE to be used for work tasks during the TAPE will be selected based on known or anticipated physical hazards; types and concentrations of contaminants that may be encountered on site; and contaminant properties, toxicity, exposure routes, and matrices. The following sections describe protective equipment and clothing; reassessment of protection levels; limitations of protective clothing; and respirator selection, use, and maintenance.

6.1 PROTECTIVE EQUIPMENT AND CLOTHING

Personnel will wear protective equipment when: (1) site activities involve known or suspected contamination; (2) site activities may generate asbestos particulates; or (3) direct contact with hazardous materials may occur. The anticipated levels of protection selected for use by field personnel during site activities are listed in Table 4-2, Task Hazard Analysis. Based on the anticipated hazard level, personnel will initially perform exterior soil sampling and indoor inspection field tasks in level D protection, described below. Based on the anticipated hazard level for non-aggressive attic entry, personnel completing this task will perform the inspection procedure in Level C PPE using at a minimum half face negative pressure respirators. Finally, based on the anticipated hazard level for aggressive attic entry, personnel completing this task will perform the inspection procedure in Level C PPE using at a minimum full face PAPR respirator or until a successful NEA is completed indicating a downgrade to half face negative pressure respirators.

If site conditions or the results of air monitoring during on-site activities warrant a higher level of protection, field personnel will immediately notify the Tetra Tech SSC. Based on the initial site walk-through and conditions encountered during sample collection, a PPE upgrade to level C protection is anticipated in some of the areas to be sampled. This PPE upgrade will typically occur whenever vermiculite-containing insulation (VCI) or Libby vermiculite (LV) is encountered. Equipment and clothing required for level D and level C protection are:

- Level D
  - Disposable Coveralls (such as Tyvek or Polypropylene coveralls)
  - Disposable gloves (latex or vinyl), if applicable
  - Work gloves, if applicable
  - Sturdy work boots or shoes
  - Disposable boot covers
  - Safety glasses or goggles
  - Hard hat (face shield optional), if needed
  - Hearing protection

- Level C
  - Disposable Coveralls (such as Tyvek or Polypropylene coveralls)
  - Outer gloves (neoprene, nitrile, or other), if applicable
  - Disposable inner gloves (latex or vinyl)
  - Sturdy work boots or shoes
  - Disposable boot covers
  - PAPR or full- or half-face, air-purifying respirator with NIOSH-approved cartridges to protect against organic vapors, dust, fumes, and mists. (Cartridges used for gas and vapors must be replaced in accordance with the change-out schedule described in the Respiratory Hazard Assessment form [Form RP-2] in Appendix C.) P-100 cartridges will be used.
  - Safety glasses or goggles (with a half-face respirator only)
  - Hard hat (face shield optional), if needed
  - Hearing protection (for areas with a noise level that exceeds 85 decibels on the A-weighted scale)

6.2 REASSESSMENT OF PROTECTION LEVELS

PPE levels will be upgraded or downgraded based on a change in site conditions or findings of the investigation. Hazards will be reassessed when a significant change in site conditions occurs. Some indicators of the need for reassessment are as follows:

- Commencement of a new phase of work, such as the start of a significantly different sampling activity or work that begins on a different portion of the site
- Potential for release of amphibole asbestos
- A change in tasks during a work phase
- A change of season or weather
- Temperature extremes or individual medical considerations that would limit the effectiveness of PPE
- Discovery of contaminants other than those previously identified
- A change in ambient levels of airborne contaminants (see the action levels listed in Table 8-1)
- A change in work scope that affects the degree of contact with contaminated media

6.3 LIMITATIONS OF PROTECTIVE CLOTHING

PPE clothing ensembles designated for use during site activities have been selected to protect against contaminants at known or anticipated on-site concentrations and physical states. However, no protective garment, glove, or boot is entirely chemical-resistant, nor does any protective clothing protect against all types of chemicals. Permeation of a chemical through PPE depends on the contaminant concentration, environmental conditions, the physical condition of the protective garment, and the resistance of the garment to the specific contaminant. Chemical permeation may continue even after the source of contamination has been removed from the garment. The Tetra Tech field staff will be trained to avoid property areas where chemical hazards are present; therefore, the use of chemical resistant PPE is not anticipated.

All site personnel will use the following procedures to obtain optimum performance from PPE:

- When protective coveralls become contaminated, don a new, clean garment after each rest break or immediately after sampling is completed.
- Inspect all clothing, gloves, and boots both before and during use for:
  - Imperfect seams
  - Non-uniform coatings
  - Tears
  - Poorly functioning closures
- Inspect reusable garments, boots, and gloves both before and during use for visible signs of chemical permeation, such as:
  - Swelling
  - Discoloration
  - Stiffness
  - Brittleness
  - Cracks
  - Punctures
  - Abrasions

Reusable gloves, boots, or coveralls that exhibit any of the characteristics listed above must be discarded. Reusable PPE will be decontaminated in accordance with procedures described in Section 10.0 and will be neatly stored in the support zone away from work zones.

6.4 RESPIRATOR SELECTION, USE, AND MAINTENANCE

Tetra Tech personnel will be informed of the proper use, maintenance, and limitations of respirators during annual health and safety refresher training and the pre-work briefing. Any on-site personnel who will use a tight-fitting respirator must pass a qualitative fit test for the respirator that follows the fit testing protocol provided in Appendix A of the OSHA respirator standard (29 CFR 1910.134). Fit testing must be repeated annually or when a new type of respirator is used. If exposure to asbestos on this project is expected to exceed 10 times the OSHA PEL, a quantitative respirator fit-test must be performed for all employees wearing respirators.

Respirators are selected based on the assessment of the nature and extent of hazardous atmospheres anticipated during field activities. This assessment includes a reasonable estimate of employee exposure to respiratory hazards and identification of each contaminant's anticipated chemical form and physical state.

A respiratory hazard assessment has been conducted for each task that will require use of a respirator during the TAPE project. The results of this assessment are documented in the Respiratory Hazard Assessment form (Form RP-2), which has been approved by the HSR. The completed Form RP-2 is included in Appendix C and defines respiratory protection requirements for the project. Amendments to this HASP and to Form RP-2 will be discussed during daily tailgate safety meetings.

When the atmospheric contaminant is identified and its concentration is known or can be reasonably estimated, respiratory protection options include:

- An air-purifying respirator equipped with a NIOSH-certified, end-of-service-life indicator (ESLI) for the identified contaminant. If no ESLI is available, a change-out schedule for cartridges must be developed based on objective data or information. The HSR will evaluate respirator cartridge selection and change-out schedules during the respiratory hazard assessment. The Respiratory Hazard Assessment, Form RP-2, will describe the information and data used as the basis for the cartridge change-out schedule and the proposed change schedule.

For protection against particulate contaminants including friable asbestos, approved respirators can include:

- A powered air purifying respirator (PAPR)
- A respirator equipped with a filter certified by NIOSH under 32 CFR Part 11 or 42 CFR Part 84 as a P100 filter (formerly known as a high-efficiency particulate air [HEPA] filter)

A PAPR or a full- or half-face, air-purifying respirator equipped with NIOSH-approved cartridges or filters will be selected to protect against particulates, vapors, gases, and aerosols for any tasks performed in level C PPE.

Air-purifying respirators will be used only in conjunction with breathing-space air monitoring, which must be conducted in adherence to the action levels outlined in Table 8-1. Air-purifying respirators will be used only when they can protect against the substances encountered on site.

Factors that would preclude use of level C and air-purifying respirators are:

- Concentrations of substances that may be immediately dangerous to life and health
- Confined or unventilated areas that may contain airborne contaminants not yet characterized
- Unknown contaminant concentrations or concentrations that may exceed the maximum use levels for designated cartridges documented in the selected cartridge manufacturer's instructions
- Unidentified contaminants
- High relative humidity (more than 85 percent, which reduces the sorbent life of the cartridges)
- Respirator cartridges with an undetermined service life

Use, cleaning, and maintenance of respirators are described in SWP 6-27, Respirator Cleaning Procedures, and SWP 6-28, Safe Work Practices for Use of Respirators. These SWPs are included in Appendix B.

7.0 MEDICAL SURVEILLANCE

The following sections describe Tetra Tech's medical surveillance program, including health monitoring requirements, site-specific medical monitoring, and medical support and follow-up requirements. Procedures documented in these sections will be followed for all activities during the TAPE project. Additional requirements are defined in the Tetra Tech, Inc., "Health and Safety Manual."

7.1 HEALTH MONITORING REQUIREMENTS

All Tetra Tech and subcontractor personnel involved in on-site activities for the TAPE project must participate in a health monitoring program as required by 29 CFR 1910.120(f). Tetra Tech has established a health monitoring program with WorkCare, Inc., of Orange, California. Under this program, Tetra Tech personnel working on this project will receive baseline and annual physical examinations consisting of:

- Complete medical and work history
- Physical examination
- Vision screening
- Audiometric screening
- Pulmonary function test
- Resting electrocardiogram
- Chest x-ray (required once every 3 years)
- Blood chemistry, including hematology and serum
- Urinalysis
- For sampling asbestos, licensed workers will meet the medical monitoring requirements of their licenses

Tetra Tech receives a copy of the examining physician's written opinion for each employee after post-examination laboratory tests have been completed. The Tetra Tech employee also receives a copy of the written opinion. This opinion includes the following information (in accordance with 29 CFR 1910.120[f][7]):

- The results of the medical examination and tests
- The physician's opinion as to whether the employee has any medical conditions that would place the employee at an increased risk of health impairment from work involving hazardous waste operations or during an emergency response
- The physician's recommended limitations, if any, on the employee's assigned work; special emphasis is placed on fitness for duty, including the ability to wear any required PPE under conditions expected on site (for example, temperature extremes)

- A statement that the employee has been informed by the physician of the medical examination results and of any medical conditions that require further examination or treatment

All subcontractors must have health monitoring programs conducted by their own clinics in compliance with 29 CFR 1910.120(f) and 29 CFR 1910.1001. Any visitors or observers at the site will be required to provide records in compliance with 29 CFR 1910.120(f) before they can enter the site.

7.2 MEDICAL SUPPORT AND FOLLOW-UP REQUIREMENTS

All employees are entitled to and encouraged to seek medical attention and physical testing as a follow-up to an injury that requires care beyond basic first aid, or to possible exposure above established exposure limits. These injuries and exposures must be reported to the HSR. Depending on the type of injury or exposure, follow-up testing, if required, must occur within 24 to 48 hours of the incident. It will be the responsibility of the employer's medical consultant to advise the type of test required to accurately monitor for exposure effects. The Tetra Tech SSC must complete the Incident Investigation Report (Form IR in Appendix A) in the event of an accident, illness, or injury. A copy of this form must be forwarded to the HSR for use in determining whether the incident should be recorded and to be included in Tetra Tech's medical surveillance records.

8.0 ENVIRONMENTAL MONITORING AND SAMPLING

Environmental monitoring or sampling will be conducted to assess personnel exposure levels as well as site or ambient conditions and to establish appropriate levels of PPE. The following sections discuss initial and background air monitoring, personal monitoring, ambient air monitoring, monitoring parameters and devices, use and maintenance of survey equipment, thermal stress monitoring, and noise monitoring. Site-specific air monitoring requirements and action levels are provided in Table 8-1.

8.1 INITIAL AND BACKGROUND AIR MONITORING

Initial air monitoring of a typical work area will be performed at the beginning of the field sampling project to document airborne fiber levels in attic spaces, in the Troy public information center and field office, and in the interior of some houses that contain VCI or LV. These background samples, designated as "stationary samples" in the TAPE, are designed to provide baseline data at the beginning of the TAPE and health and safety quality assurance periodically during the process. Background micro-vacuum samples will also be collected inside Tetra Tech's rental vehicles at the beginning of the project, monthly during the project, and prior to returning the vehicles.

Initial exposure assessments will also be required for personnel who participate in the TAPE project. Personal air monitoring will be required during the initial phase of the TAPE to document airborne exposures. The assessments must be used to document typical exposures during specific types of field activities to establish the PPE level required during these activities.

This exposure assessment will be conducted for each field sampling team. The exposure levels must be documented before the levels of PPE required during the work can be downgraded. The assessments must also be conducted using personal air sampling whenever there is a change in working conditions or tasks being performed.

TABLE 8-1

SITE-SPECIFIC AIR MONITORING REQUIREMENTS AND ACTION LEVELS

Contaminant or Hazard	Task	Monitoring Device	Action Level	Monitoring Frequency	Action[a]
Asbestos	Tasks 1 and 2	Gilair-5 Air Sampler (personal)	<one half of PEL or TLV	Select locations – presence of friable asbestos	Results will be received the day after sampling. Work practices will be changed accordingly.

Notes:

< Le ss than
PEL Permissible exposure limit
TLV Threshold limit value
[a] Refer to Table 4-2 for specific types of gloves, chemical resistant clothing, respirators, and cartridges

8.2 PERSONAL MONITORING

The employees working closest to a source of contamination have the highest likelihood of exposure to airborne contaminant concentrations that may exceed established exposure limits. Therefore, the workers who are closest to a source of contaminant generation will be selectively monitored during site activities. Personal monitoring will be conducted in the breathing zone and, if a worker is wearing respiratory protective equipment, outside the face piece. The breathing zone air will be monitored for Tetra Tech employees working at select locations, such as in the presence of friable asbestos. Work that results in potential employee exposure to airborne asbestos above the prescribed PEL or short term exposure limit (STEL) requires an exposure assessment regulated under the OSHA reference method 29 CFR Part 1910.1001. The determinations of employee exposure will be made from breathing zone air samples representative of the 8-hour TWA and 30-minute STEL for each employee work category. The PEL is 0.1 f/cc for the 8-hour TWA, and the STEL is 1.0 f/cc over a 30-minute period as set forth in 29 CFR Part 1910.1001 (j)(2)(iii).

Many activities anticipated during the TAPE may cause exposure of workers to LA. These activities include Task 1 and 2 procedures. If sampling or disturbance of these materials occurs by duly trained employees, initial air monitoring will be required since such activities could constitute asbestos disturbance procedures as defined by 29 CFR Part 1926.1101. The initial exposure assessments will be representative of each specific work situation at hand. Factors to be weighed include (but are not limited to) type of work, condition of the materials, air monitoring results from similar tasks, and all elements that could make the work more difficult (such as obstructions, high temperature areas, and poor reach areas). Tetra Tech anticipates collecting initial exposure assessment samples for each employee job category for each project team. Exposure assessment samples will also be collected on new field team members that rotate into the project over the course of the TAPE. Exposure assessment samples will also be collected periodically during the course of the TAPE as part of Tetra Tech's Quality Assurance and Quality Control (QA/QC) process.

Tetra Tech initial exposure assessments will be designed to provide NEAs to demonstrate that employee exposures will be below the PEL or STEL for each representative TAPE tasks. The monitoring and analysis will be performed in compliance with the OSHA asbestos standard in effect. The NEA can be used in the initial exposure assessment to reduce or eliminate the need for respiratory protection if all applicable criteria are met.

Air monitoring will be performed to calculate the air borne fiber concentration to ensure that employee exposure remains below the PEL and STEL The worker's exposure will be measured by first collecting an air sample from within the breathing zone (within 12 inches from the nose) throughout an entire work-shift. This measurement usually necessitates that workers wear the pump near the waist. The personal air monitoring will be evaluated based on the different work activities that are being conducted. A representative set of air samples will be collected during activities that represent typical field days during the TAPE.

The sampling pump flow rates will be between 0.5 liters/minute and 2.5 liters/minute when using a 25-millimeter cassette. Once this sample is analyzed, the results shall be used to calculate the average level of exposure during the complete workshift (the time weighted average, TWA). The TWA is calculated as follows:

$$TWA = \frac{C1\ T1 + C2\ T2 + C3\ T3}{T1 + T2 + T3}$$

T = sample times (duration of exposure in minutes or hours)
C = airborne asbestos fiber concentration (in fibers per cubic centimeter, f/cc)

The TWA results will then be used for comparison to the PEL and to evaluate compliance with permissible exposure limits as established by OSHA. They will also be used to dictate which type of respiratory protection is required to ensure that the PEL is not exceeded.

Personal air samples will also be collected and analyzed in the manner described above for comparison to the PEL and STEL. Sample filters will be analyzed using Phase Contrast Microscopy (PCM) methodology by laboratory personnel (1) trained in NIOSH 582 microscopist (or equivalent) courses and (2) participating in a quality control program meeting the requirements established in 29 CFR 1926.1101. The NIOSH method used for this analysis will be Method 7400. The PCM analytical method is designed to identify all fibers of specific size and shape characteristics but not to distinguish between asbestos and non-asbestos fibers. PCM sample results are reported in fibers per cubic centimeter of air (f/cc). Tetra Tech will request that all sample filters be returned from the laboratory after analysis to be archived. Tetra Tech will use one of several laboratories for analysis, including: (1) Betta Environmental Associates, Inc. in Newark, Delaware; (2) EMSL Analytical, Inc. in Westmond, New Jersey; (3) EMSL Analytical, Inc. in Libby, Montana; (4) Hygeia Laboratories, Inc. in Sierra Madre, California, (5) MAS in

Suwannee, Georgia; and (6) Reservoirs Environmental, Inc. in Denver, Colorado. All of these laboratories are accredited though the National Voluntary Laboratory Accreditation Program (NVLAP).

8.3 MONITORING PARAMETERS AND DEVICES

The following sections below briefly describe the use and limitations of instruments used to monitor for asbestos, combustible atmospheres, percent oxygen, and particulates. Site-specific air monitoring requirements and action levels are listed in Table 8-1.

All monitors will be calibrated in accordance with manufacturer recommendations prior to and subsequent to use for sampling purposes (pre-and post-calibration). Pre and post-calibration results will be averaged to determine the average flow-rate being drawn through the pump for a particular sampling period. Calibration data and other pertinent air monitoring data will be recorded in the field logbook.

8.3.1 Asbestos

Air monitoring will be conducted selectively during sampling to provide information on exposure and identify the need for upgrades from level D PPE to level C PPE. In addition, air monitoring will be conducted to make certain that asbestos is not being released to the areas used by workers as a result of sampling.

Work during the TAPE will be initially conducted in level C PPE; however, after negative exposure assessments are documented, level D will be allowed for exterior soil sampling procedures if no visible VCI or LV is present. Level C PPE using, at a minimum, half face negative pressure respirators, will be required whenever non-aggressive attic access is required or whenever VCI or LV is sampled. Level C PPE using PAPR respirators will be required whenever aggressive attic access is required or until a successful NEA is completed indicating a downgrade to half face negative pressure respirators. The action level (the level at which PPE will be upgraded from Level D to Level C) for sampling activities is one-half the PEL (0.05 f/cc). Additionally, upgrade to level C PPE will also be based on the material sampled and at the discretion of the SSC. Personal air monitoring for particulates will be analyzed by laboratories accredited though the NVLAP. Laboratory results will be received less than 1 day after actual exposure to assist assessing sampling conditions and change PPE accordingly.

8.3.2 Particulates

Friable asbestos is anticipated to be encountered during sampling. Other unanticipated particulates, such as mineral wood, fiberglass, and other insulating materials, may be encountered in attic areas.

Particulate air monitoring is the process of measuring the fiber content of a known volume of air collected during a specific period of time. The acceptable procedure for airborne asbestos measurement for personal exposure monitoring is PCM using the OSHA reference method specified in Appendix A of 29 CFR 1926.1101. NIOSH Method 7400 is an equivalent and acceptable method for measuring airborne fiber levels in area samples. The NIOSH method will be used for initial employee exposure monitoring. The standard detection limit is <0.01 f/cc. If lower levels of detection are required, the sample volume and collection time period should be increased. Adjustments to sample volume and time should be selected to obtain a fiber density between 100 to 1,300 fibers/mm^2.

In both sampling methods above, any fiber with an aspect ratio (measure of length vs. width) of greater than 3 to 1 is counted as an asbestos fiber. In areas with significant amounts of fibers such as fiberglass, the PCM method may overestimate the number of asbestos fibers in the air, and thus the exposure to employees. In this circumstance, a more selective method of asbestos identification will be employed, as explained below.

The acceptable procedure for airborne asbestos measurement by transmission electron microscopy (TEM) is the method EPA specified in 40 CFR 763, Appendix A to Subpart E, Interim Transmission Electron Microscopy Analytical Methods. NIOSH method 7402 is the equivalent TEM method to 40 CFR 763, Appendix A to Subpart E. TEM sampling provides greater analytical sensitivity and can differentiate between asbestos and non-asbestos fibers. TEM analysis of employee exposure samples will be limited during the TAPE, only being conducted if PCM samples cannot be analyzed due to overloading from nuisance particulates, or when fibers must be differentiated because the PEL is exceeded. If such instances arise, samples may be reanalyzed by TEM using NIOSH Method 7402.

8.4 USE AND MAINTENANCE OF SURVEY EQUIPMENT

All personnel using field survey equipment must have experience or training in its operation, limitations, and maintenance. Before they are used on site, maintenance and internal or electronic calibration will be

performed in accordance with manufacturer recommendations by personnel who are familiar with the devices. Repairs, maintenance, and internal or electronic calibration of these devices will be recorded in an equipment maintenance logbook. Results of routine calibration will be recorded on daily air sampling data sheets.

8.5 THERMAL STRESS MONITORING

Heat stress and cold stress are common and serious threats at hazardous waste sites. SWPs 6-15 and 6-16 discuss heat and cold stress and include monitoring methods appropriate for the season and location of work (see Appendix B). The SSC will ensure proper coordination of employees adhering to SWP 6-15 and 6-16.

9.0 SITE CONTROL

Site control is an essential component in HASP implementation. The following sections discuss measures and procedures for site control, such as on-site communications, site control zones, site access control, site safety inspections, and SWPs.

9.1 ON-SITE COMMUNICATIONS

Successful communication between field teams and personnel is essential. The following communication systems will be available during site activities:

- Cellular telephones or two-way radios

The hand signals listed below will be used by site personnel in emergency situations or when verbal communication is difficult.

Signal	Definition
Hands clutching throat	Out of air or cannot breathe
Hands on top of head	Need assistance
Thumbs up	Okay, I am all right, or I understand
Thumbs down	No or negative
Arms waving upright	Send backup support

Signal	Definition
Gripping partner's wrist	Exit area immediately

9.2 SITE CONTROL ZONES

The following site control zones will be established for each property and work task.

9.2.1 Zone 1: Exclusion Zone

An exclusion zone includes areas where contamination is either known or likely to be present or, because of work activity, has the potential to cause harm to personnel. During the TAPE, these areas will typically be limited to attics and crawl spaces. The exclusion zone will be established before Tetra Tech employees access attic areas or crawl spaces to collect samples. During sampling procedures, the Tetra Tech field team will restrict building occupants and visitors from entering the exclusion zone. Work tasks that may require establishment of an exclusion zone include the following:

Task 1– Interior inspection of VCI and LV in attics and crawl spaces.

Exclusion zones will not be established during collection of soil samples outside the buildings. However, building occupants should be restricted from the immediate area during sampling procedures. Exclusion zones shall be established during aggressive and non-aggressive attic inspections, whereby building occupants are restricted from the attic access staging rooms during the inspection procedures.

9.2.2 Zone 2: Decontamination Zone

Decontamination zones will be established during the TAPE project, in locations such as at the base of ladders used to access attic spaces or outside of crawl space entrances. These areas will be covered with one layer of polyethylene sheeting during sampling in the exclusion zones. Personal decontamination will entail removing of protective garments after field crews descend from attic areas or leave crawl spaces. During aggressive attic inspection procedures staged from the interior of a building, decontamination zones will be confined inside the polyethylene staging chambers. Tetra Tech personnel will use disposable wet wipes and/or wet towels to wash respirators and exposed areas such as faces and hands. Sampling equipment will be decontaminated at the sample locations. Decontamination procedures will consist of a water rinse or damp rag cleaning of equipment after each sample collected.

The decontamination zone will contain facilities to decontaminate personnel and portable equipment. Equipment decontamination procedures are described in Section 10.0. All PPE and polyethylene sheeting will be place in disposal bags and sealed before Tetra Tech employees leave the decontamination zones. After personal and equipment decontamination are complete and polyethylene sheeting is removed, decontamination areas will be cleaned of debris and residue using appropriate HEPA vacuuming or wet cleaning procedures. Visitors, including building occupants, will not be permitted to enter the decontamination zone without proper qualifications and Tetra Tech SSC authorization.

9.2.3 Zone 3: Support Zone

A support zone may consist of any uncontaminated and non-hazardous part of the site, such as areas adjacent to decontamination zones at the base of ladders used to access attic spaces or outside of crawl space entrances. After the exclusion zone has been established, sampling procedures will immediately stop if visible suspect asbestos-contaminated debris is observed outside of the sampling or decontamination areas at any time during sampling. Debris and residue will be cleaned up using appropriate HEPA vacuuming or wet cleaning procedures before work recommences. Site visitors who do not meet training, medical surveillance and PPE requirements may enter the support zone upon approval by the Tetra Tech SSC unless visible suspect asbestos-contaminated debris is observed in the area.

9.3 SITE ACCESS CONTROL

The study area during this project will not be one stationary location. Access to private residences will be with the permission of the owner. Owners and occupants should be restricted from the immediate areas during sampling procedures. Typically, they should be asked to stay in adjacent rooms during sampling procedures.

9.4 SITE SAFETY INSPECTIONS

To maintain safe work areas and compliance with this HASP, the Tetra Tech SSC will conduct one site safety inspection for each month spent on-site. Results of the site safety inspections will be recorded on a Field Audit Checklist (Form AF-1 in Appendix A).

9.5 SAFE WORK PRACTICES

Various SWPs are applicable during the TAPE project. These SWPs are included in Appendix B of this HASP. The following SWPs apply to the site:

- SWP 6-1, General Safe Work Practices
- SWP 6-8, Safe Electrical Work Practices
- SWP 6-9, Fall Protection Practices
- SWP 6-10, Portable Ladder Safety
- SWP 6-15, Heat Stress
- SWP 6-16, Cold Stress
- SWP 6-27, Respirator Cleaning Procedures
- SWP 6-28, Safe Work Practices for Use of Respirators
- SWP 6-29, Respirator Qualitative Fit Testing Procedures

10.0 DECONTAMINATION

Decontamination is the process of removing or neutralizing contaminants on personnel or equipment. When properly conducted, decontamination procedures protect workers from contaminants that may have accumulated on PPE, tools, rental vehicles and other equipment. Proper decontamination also prevents transport of potentially harmful materials to uncontaminated areas. Personnel and equipment decontamination procedures are described in the following sections.

10.1 PERSONNEL DECONTAMINATION

Personnel decontamination at the site will be limited by using disposable PPE whenever possible and by wet wiping of faces and hands after sampling procedures. Any personnel decontamination procedures will follow guidance in the *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH and others 1985). Personnel and PPE will be decontaminated with potable water or a mixture of detergent and water. Disposable cloths or wet wipes will be placed in sealable baggies pending disposal.

10.2 EQUIPMENT DECONTAMINATION

Decontamination of all sampling, PPE, and field monitoring equipment used during site activities will be required. Decontamination of sampling equipment will be conducted at the sample locations. Decontamination procedures will consist of a water rinse or damp rag cleaning of equipment after each sample collected. As part of Tetra Tech quality assurance and general health and safety procedures, the interior of all rental vehicles will also be HEPA vacuumed wet wiped bi-monthly to ensure cleanliness.

10.2.1 PPE and Monitoring Equipment

Used, disposable PPE will be collected in sealable containers and will be disposed of in accordance with procedures described in the project specific work plan. Personnel decontamination procedures may be modified as necessary while on site. All non-disposable PPE such as hard hats, respirators, and any exposed clothing will be washed at the end of each workday, or as necessary depending on working conditions, to remove all potential for asbestos contamination. Monitoring equipment used during sampling will be rinsed with water at the end of each workday, or as necessary to remove any contamination.

10.2.2 Sam pling Equipment

Sampling equipment, such as stainless steel mixing bowls will be decontaminated before and after each use as described below:

- Decontamination procedures for sampling equipment will depend on the sampling location. In most sampling situations equipment will, be decontaminated by wiping down with damp cloths or rags. Soap and water may be necessary (but are not mandatory) when items are excessively dirty.
- Sampling equipment will be wiped down with disposable paper towels or be allowed to air-dry before the next use.

11.0 EMERGENCY RESPONSE PLANNING

This section describes emergency response planning procedures to be implemented for the site. This section is consistent with local, state, and Federal disaster and emergency management plans. The following sections discuss pre-emergency planning, personnel roles and lines of authority, emergency recognition and prevention, evacuation routes and procedures, emergency contacts and notifications, hospital route directions, emergency medical treatment procedures, protective equipment failure, fire or explosion, weather-related emergencies, spills or leaks, emergency equipment and facilities, and reporting.

11.1 PRE-EMERGENCY PLANNING

All on-site employees will be trained in and reminded of the provisions of Section 11.0, site communication systems, and site evacuation routes during the pre-work briefing and daily tailgate safety meetings. The Tetra Tech SSC will review the emergency response provisions on a regular basis and they will be revised, if necessary, to make certain that they are adequate and consistent with prevailing site conditions.

11.2 PERSONNEL ROLES AND LINES OF AUTHORITY

The Tetra Tech SSC has primary responsibility for responding to and correcting emergencies and for taking appropriate measures to maintain the safety of site personnel and the public. Possible actions may include evacuation of personnel from the site area. The SSC is also responsible for ensuring that corrective measures have been implemented, appropriate authorities have been notified, and follow-up reports have been completed.

Individual subcontractors are required to cooperate with the SSC, within the parameters of their scopes of work.

Personnel are required to report all injuries, illnesses, spills, fires, and property damage to the SSC immediately. The SSC must be notified of any on-site emergencies and is responsible for following the appropriate emergency procedures described in this section.

11.3 EMERGENCY RECOGNITION AND PREVENTION

Table 4-1 lists potential on-site chemical hazards, and Table 4-2 provides information on the hazards associated with the various tasks planned for the site. On-site personnel will be made familiar with this information and with techniques of hazard recognition through pre-work training and site-specific briefings.

11.4 EVACUATION ROUTES AND PROCEDURES

In the event of an emergency that necessitates evacuation of a work task area or the site, the Tetra Tech SSC will contact all nearby personnel using the on-site communication systems discussed in Section 9.1 to advise the personnel of the emergency. The personnel will proceed along site roads to a safe distance upwind from the source of the hazard. The personnel will remain in that area until the SSC or an authorized individual provides further instructions.

11.5 EMERGENCY CONTACTS AND NOTIFICATIONS

The emergency information preceding Section 1.0 of this HASP provides names and telephone numbers of emergency contact personnel. This page must be posted on site or must be readily available at all times. In the event of a medical emergency, personnel will notify the appropriate emergency organization and will take direction from the Tetra Tech SSC. The project team will follow procedures discussed in Section 11.9 or 11.11.

11.6 HOSPITAL ROUTE DIRECTIONS

Before site activities begin, Tetra Tech personnel will conduct a pre-emergency hospital run to familiarize themselves with the route to the local hospital. A map showing the hospital route is provided in the emergency information preceding Section 1.0 of this HASP.

11.7 EMERGENCY MEDICAL TREATMENT PROCEDURES

A person who becomes ill or injured during work may require decontamination. If the illness or injury is minor, any decontamination necessary will be completed and first aid should be administered before the patient is transported. If the patient's condition is serious, partial decontamination will be completed (such as complete disrobing of the person and redressing the person in clean coveralls or wrapping in a

blanket). First aid should be administered until an ambulance or paramedics arrive. All injuries and illnesses must be reported immediately to the Tetra Tech project manager and HSR.

11.8 PROTECTIVE EQUIPMENT FAILURE

If any worker in the exclusion zone experiences a failure of protective equipment (either engineering controls or PPE) that affects his or her personal protection, the worker and all coworkers will immediately leave the exclusion zone. Re-entry to the exclusion zone will not be permitted until: (1) the protective equipment has been repaired or replaced, (2) the cause of the equipment failure has been determined, and (3) the equipment failure is no longer considered to be a threat.

11.9 FIRE OR EXPLOSION

In the event of a fire or explosion on site, fire department will be immediately summoned. The Tetra Tech SSC or a site representative will advise the fire department of the location and nature of any hazardous materials involved. Appropriate provisions of Section 11.0 will be implemented by site personnel.

11.10 WEATHER-RELATED EMERGENCIES

Work will not be conducted during severe weather conditions, including high-speed winds or lightning. In the event of severe weather, field personnel will stop work, secure and lower all equipment, and leave the site.

Thermal stress caused by excessive heat or cold may occur as a result of extreme temperatures, workload, or the PPE used. Heat and cold stress treatment will be administered as described in SWPs 6-15 and 6-16.

11.11 EMERGENCY EQUIPMENT AND FACILITIES

The following emergency equipment will be available on site:

- First aid kit
- Fire extinguisher
- Site telephones, depending on location
- Mobile telephone
- Confined-space entry equipment, as necessary
- Fall protection equipment, as necessary

11.12 REPORTING

All emergencies require follow-up and reporting. Appendix A includes the Tetra Tech Incident Report (Form IR). This report must be completed and submitted to the Tetra Tech project manager and Regional Safety Officer (RSO) within 24 hours of an emergency. The project manager will review the report and then forward it to the Tetra Tech HSR for review. The report must include proposed actions to prevent similar incidents from occurring. The HSR must be fully informed of the corrective action process so that he may implement applicable elements of the process at other sites.

REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH). "Threshold Limit Values and Biological Exposure Indices for 1998." Latest edition.

National Institute for Occupational Safety and Health (NIOSH) and others. 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. October.

NIOSH. 1997. "Pocket Guide to Chemical Hazards." U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. June.

Tetra Tech, Inc. 1999. "Health and Safety Manual."

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX A

TETRA TECH FORMS

(11 Sheets)

- Compliance Agreement (Form HSP-4)
- Daily Tailgate Safety Meeting (Form HST-2)
- Daily Site Log (Form SSC-1)
- Accident and Illness Investigation Report (Form IR, IR-A, IR-B, IR-C, HIPAA Form)
- Field Audit Checklist (Form AF-1)
- Air Sampling Data Sheet (Stationary and Personal Air Sampling)

TETRA TECH, INC.

HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT

Project Name: _____

Project Number: _____

I have read and understand the health and safety plan indicated above and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Name	Signature	Employer	Date

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM

Date: _____ Time: _____ Project No.: _____

Client: _____ Site Location: _____

Site Activities Planned for Today: _____

_____

Safety Topics Discussed
Protective clothing and equipment:
Chemical hazards:
Physical hazards:
Environmental and biohazards:
Equipment hazards:
Decontamination procedures:
Other:
Review of emergency procedures:
Employee Questions or Comments:

TETRA TECH, INC.

DAILY TAILGATE SAFETY MEETING FORM (Continued)

Attendees	
Printed Name	**Signature**

Meeting Conducted by:

_____ _____

Name Title

_____

Signature

TETRA TECH, INC.

DAILY SITE LOG

Site Name:_____ Date: _____

Name (print)	Company	Time	
		In	Out

Comments:

_____

_____

_____

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT

To: _____
Subsidiary Health and Safety Representative

Cc: _____
Workers Compensation Administrator

Project name: _____

Project number. _____

Prepared by: _____

Position: _____

Office: _____

Telephone number: _____

Fax number: _____

Information Regarding Injured or Ill Employee

Name: _____

Office: _____

Home address: _____

_____

Gender: M ☐ F ☐ No. of dependents: _____

Marital status: _____

Home telephone number: _____

Date of birth: _____

Occupation (regular job title): _____

Social Security Number: _____

Department: _____

Date of Accident: _____

Time Employee Began Work: _____

Time of Accident: _____ a.m. ☐ p.m. ☐

☐ Check if time cannot be determined

Location of Accident

Street address: _____

City, state, and zip code: _____

County: _____

Was place of accident or exposure on employer's premises? Yes ☐ No ☐

Information About the Case

What was the employee doing just before the incident occurred?: Describe the activity, as well as the tools, equipment, or material the employee was using. Be specific. Examples: "climbing a ladder while carrying roofing materials"; "spraying chlorine from hand sprayer"; "daily computer key-entry."

What Happened?: Describe how the injury occurred. Examples: "When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time."

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Information About the Case (Continued)

What was the injury or illness? Describe the part of the body that was affected and how it was affected; be more specific than "hurt," "pain," or "sore." Examples "strained back"; "chemical burn, right hand"; "carpal tunnel syndrome, left wrist."

Describe the Object or Substance which Directly Harmed the Employee: Examples: "concrete floor"; "chlorine"; "radial arm saw." If this question does not apply to the incident, enter a NA.

Did the employee die? Yes ☐ No ☐ Date of death: _____

Was employee performing regular job duties? Yes ☐ No ☐

Was safety equipment provided? Yes ☐ No ☐ Was safety equipment used? Yes ☐ No ☐

Note: Attach any police reports or related diagrams to this accident report.

Witness(es):

Name: _____

Company: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Name: _____

Company: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Medical Treatment Required? ☐ Yes ☐ No ☐ First Aid only

Name of physician or health care professional: _____

If treatment was provided away from the work-site, where was it given?

Facility name: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Was the employee treated in an emergency room? ☐ Yes ☐ No

Was the employee hospitalized overnight as an in-patient? ☐ Yes ☐ No

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Corrective Action(s) Taken by Unit Reporting the Accident:

Corrective Action Still to be Taken (by whom and when):

Name of Tetra Tech employee the injury or illness was first reported to: _____

Date of Report: _____ **Time of Report:** _____

I have reviewed this investigation report and agree, to the best of my recollection, with its contents.

_____ _____

Printed Name of Injured Employee Telephone Number

_____ _____

Signature of Injured Employee Datee

The signatures provided below indicate that appropriate personnel have been notified of the incident.

Title	Printed Name	Signature	Telephone Number	Date
Project or Office Manager				
Site Safety Coordinator				

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

To be completed by the Subsidiary Safety and Health Representative:

Classification of Incident:

☐ Injury ☐ Illness

Result of Incident:

☐ First Aid Only

☐ Days Away From Work

☐ Remained at Work but Incident Resulted in Job Transfer or Work Restriction

☐ Incident Involved Days Away and Job Transfer or Work Restriction

☐ Medical Treatment Only

No. of Days Away From Work _____

Date Employee Left Work _____

Date Employee Returned to Work _____

No. of Days Placed on Restriction or Job Transfer: _____

OSHA Recordable Case Number _____

To be completed by Human Resources:

SSN: _____

Date of hire: _____ Hire date in current job: _____

Wage information: $ _____ per ☐ Hour ☐ Day ☐ Week ☐ Month

Position at time of hire: _____

Current position: _____ Shift hours: _____

State in which employee was hired: _____

Status: ☐ Full-time ☐ Part-time Hours per week: _____ Days per week: _____

Temporary job end date: _____

To be completed during report to workers' compensation carrier:

Date reported: _____ Reported by: _____

Confirmation number: _____

Name of contact: _____

Field office of claims adjuster: _____

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

FIELD AUDIT CHECKLIST

Project Name: _____ Project No.: _____

Field Location: _____ Completed by: _____

Project Manager: _____ Site Safety Coordinator: _____

General Items		In Compliance?		
Health and Safety Plan Requirements		Yes	No	NA
1	Approved health and safety plan (HASP) on site or available			
2	Names of on-site personnel recorded in field logbook or daily log			
3	HASP compliance agreement form signed by all on-site personnel			
4	Material Safety Data Sheets on site or available			
5	Designated site safety coordinator present			
6	Daily tailgate safety meetings conducted and documented			
7	On-site personnel meet HASP requirements for medical examinations, fit testing, and training (including subcontractors)			
8	Compliance with specified safe work practices			
9	Documentation of training, medical examinations, and fit tests available from employer			
10	Exclusion, decontamination, and support zones delineated and enforced			
11	Windsock or ribbons in place to indicate wind direction			
12	Illness and injury prevention program reports completed (California only)			
Emergency Planning				
13	Emergency telephone numbers posted			
14	Emergency route to hospital posted			
15	Local emergency providers notified of site activities			
16	Adequate safety equipment inventory available			
17	First aid provider and supplies available			
18	Eyewash stations in place			
Air Monitoring				
19	Monitoring equipment specified in HASP available and in working order			
20	Monitoring equipment calibrated and calibration records available			
21	Personnel know how to operate monitoring equipment and equipment manuals available on site			
23	Environmental and personnel monitoring performed as specified in HASP			

TETRA TECH, INC.

FIELD AUDIT CHECKLIST (Continued)

Safety Items		In Compliance?		
Personal Protection		Yes	No	NA
1	Splash suit			
2	Chemical protective clothing			
3	Safety glasses or goggles			
4	Gloves			
5	Overboots			
6	Hard hat			
7	Dust mask			
8	Hearing protection			
9	Respirator			
Instrumentation				
10	Combustible gas meter			
11	Oxygen meter			
12	Organic vapor analyzer			
Supplies				
13	Decontamination equipment and supplies			
14	Fire extinguishers			
15	Spill cleanup supplies			
Corrective Action Taken During Audit:				
Corrective Action Still Needed:				

Note: NA = Not applicable

_____ _____

Auditor's Signature Site Safety Coordinator's Signature

_____

Date

AIR SAMPLING ANALYSIS REQUEST FORM
CHAIN OF CUSTODY

Tetra Tech EM, Inc.
Power Block Building
7 West 6th Avenue, Suite 612
Helena, Montana 59601
Office # (406) 442-5588
Fax # (406) 442-7182

Project Name:	Troy Asbestos Property Evaluation (TAPE)
Project No:	
Collected By:	
Turn-Around Time[1]:	

Tetra Tech Sample #	Lab I.D.#	Date Collected	Sample Category[2]	Sample Type[3]	Sample Medium[4]	Sample Pore Size[5]	Time On Time Off Total Minutes	Flow Rate-Start Flow Rate-Stop Total Volume	Sample Location(s)[6]	Stationary / Personal	Activity[7]
							/	/			
							/	/			
							/	/			
							/	/			
							/	/			
							/	/			
							/	/			
							/	/			
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							/	/			

Special Instructions/Comments:_____

*** Contact Person**:_____ *** Contact #**: ( ) _____ **Analytical Laboratory**:) _____

Samples Relinquished By:_____Date (/ /) Time (:) Samples Received By:_____Date (/ /) Time (:)
Samples Relinquished By: _____Date (/ /) Time (:) Samples Received By:_____Date (/ /) Time (:)
Samples Relinquished By: _____Date (/ /) Time (:) Samples Received By:_____Date (/ /) Time (:)

1) RUSH, 4HR, 8HR, 12HR, 24HR, Other. 2) (P) = Perimeter, (E) = Excursion, (D) = Duration, (C) = Clearance, (B) = Background, (O) = Other. 3) PCM (AHERA) (NIOSH 7400), TEM (AHERA) (NIOSH 7402) (Yamate 2), AA, Non-Viable Fungi, Nuisance (Respirable) Dust, TVOC, Metals, Other.
4) MCE, PVC, Matched Weight, Other. 5) 0.45µm (TEM), 0.8µm (PCM), Other. 6) Property address(s) and building number(s). 7) Stationary or Personal 8) Field sampling, data entry, office

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX B

SAFE WORK PRACTICES

(38 Sheets)

- SWP 6-1 General Safe Work Practices
- SWP 6-9 Fall Protection Practices
- SWP 6-10 Portable Ladder Safety
- SWP 6-15 Heat Stress
- SWP 6-16 Cold Stress
- SWP 6-27 Respirator Cleaning Procedures
- SWP 6-28 Safe Work Practices for Use of Respirators
- SWP 6-29 Respirator for Qualitative Fit Testing Procedures

TETRA TECH, INC.
HEALTH AND SAFETY MANUAL
VOLUME III

SAFE WORK PRACTICES (SWP)

GENERAL SAFE WORK PRACTICES

SWP NO.: 6-1

ISSUE DATE: JULY 1998

REVISION NO.: 1

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GENERAL SAFE WORK PRACTICES

To prevent injuries and adverse health effects, the following general safe work practices (SWP) are to be followed when conducting work involving known and unknown site hazards. These SWPs establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations. This list is not inclusive and may be amended as necessary.

- Do not eat, drink, chew gum or tobacco, take medication, or smoke in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists.
- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. A thorough shower and washing must be conducted as soon as possible if excessive skin contamination occurs.
- Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on drums, equipment, or the ground. Do not place monitoring equipment on potentially contaminated surfaces.
- Remove beards or facial hair that interfere with a satisfactory qualitative respirator fit test or routine pre-entry positive and negative pressure checks.
- Be familiar with and knowledgeable of and adhere to all instructions in the site-specific health and safety plan (HASP). At a minimum, a safety meeting will be held at the start of each project to discuss the HASP. Additional meetings will be held, as necessary, to address new or continuing safety and health concerns.
- Be aware of the location of the nearest telephone and all emergency telephone numbers.
- Attend a briefing on the anticipated hazards, equipment requirements, SWPs, emergency procedures, and communication methods before going on site.
- Plan and delineate entrance, exit, and emergency escape routes.
- Rehearse unfamiliar operations prior to implementation.
- Use the “buddy system” whenever respiratory protection equipment is in use. Buddies should establish hand signals or other means of emergency communication in case radios break down or are unavailable.
- Buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.

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- Minimize the number of personnel and equipment in contaminated areas (such as the exclusion zone). Nonessential vehicles and equipment should remain within the support zone.

- Establish appropriate support, contamination reduction, and exclusion zones.

- Establish appropriate decontamination procedures for leaving the site.

- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the site safety coordinator (SSC).

- Maintain a portion of the site field logbook as a project safety log. The project safety log will be used to record the names, entry and exit dates, and times on site of all Tetra Tech, subcontractor, and project site visitor personnel; air quality and personal exposure monitoring data; and other information related to safety matters. Form SSC-1, Daily Site Log, may be used to record names of on-site personnel.

- A portable eyewash station should be located in the support zone if chemical splashes to eyes are possible.

- Do not bring matches and lighters in the exclusion zone or contamination reduction zone.

- Observe coworkers for signs of toxic exposure and heat or cold stress.

- Inform coworkers of nonvisual effects of illness if you experience them, such as headaches, dizziness, nausea, or blurred vision.

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SAFE WORK PRACTICES (SWP)

FALL PROTECTION PRACTICES

SWP NO.: 6-9

ISSUE DATE: JULY 1998

REVISION NO.: 1

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FALL PROTECTION PRACTICES

This safe work practice (SWP) presents general guidelines for basic fall protection when working in elevated areas. Continuous elevated work or elevated construction work will require detailed procedures included in a site-specific health and safety plan. SWP No. 6-10, "Portable Ladder Safety," should also be consulted. During elevated work, the precautions below must be taken.

- All fall hazards should be identified at work sites with the potential for elevated work. Once an elevated fall hazard has been recognized, an appropriate control measure must be selected. Priority should be given to elimination of the fall hazard over the use of fall protection equipment.
- Approved safety harnesses and lanyards shall be worn by employees whose work exposes them to falls of greater than 6 feet.
- Lanyards should be anchored at a level no lower than the employee's waist to limit the fall distance to a maximum of 4 feet and to not allow the employee to contact the next lower work level, where practical.
- All fall protection devices should be used only in accordance with manufacturer's recommendations.
- All fall protection devices shall be inspected daily before use.
- Any lifeline, harness, or lanyard actually subjected to in-service loading (a fall) should be immediately removed from service and not used again for employee fall protection.
- Anchor points and lanyards capable of supporting a minimum dead weight of 5,400 pounds should be used.
- Employees who are required to wear fall protection should be trained in the use of the equipment, as well as in fall protection work practices.

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SAFE WORK PRACTICES (SWP)

PORTABLE LADDER SAFETY

SWP NO.: 6-10

ISSUE DATE: JULY 1998

REVISION NO.: 1

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PORTABLE LADDER SAFETY

This safe work practice (SWP) applies to portable ladders only. Fixed ladder systems shall be used when regular access is required such as for entering storage tanks and raised work platforms. These SWPs follow the regulatory requirements for ladders as found in Title 29 of the *Code of Federal Regulations* (CFR) Part 1926.1053. Procedures to ensure portable ladder safety are listed below.

- Ladders should be maintained in good condition at all times. Damaged ladders shall be withdrawn from service immediately.
- Ladders should be inspected regularly and removed from service and repaired or discarded if defective.
- Rungs should have slip-resistant surfaces and be kept free of grease and oil.
- Tops and pail shelves of portable stepladders should not be used as steps.
- Rung and cleat ladders should be placed so that the horizontal distance from the top support to the foot of the ladder is one-quarter of the working length of the ladder.
- Ladders should not be placed in front of doorways, drives, or passageways.
- Ladders should not be placed on boxes, barrels, or other unstable bases to add height.
- Employees should always face the ladder during ascent or descent.
- Metal ladders should not be used in areas with the potential for contact with electric circuits.
- Ladder side rails shall extend at least 3 feet above the upper landing surface to which the ladder is used to access.
- Ladder shall be used only on stable and level surfaces. Do not use ladders on slippery surfaces.

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SAFE WORK PRACTICES (SWP)

HEAT STRESS

SWP NO.: 6-15

ISSUE DATE: JULY 1998

REVISION NO.: 1

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HEAT STRESS

This safe work practice (SWP) describes situations where heat stress is likely to occur and provides procedures for the prevention and treatment of heat-related injuries and illnesses. Wearing personal protective equipment (PPE), especially during warm weather, puts employees at considerable risk of developing heat-related illness. Health effects from heat stress may range from transient heat fatigue or rashes to serious illness or death.

Many factors contribute to heat stress, including PPE, ambient temperature and humidity, workload, and the physical condition of the employee, as well as predisposing medical conditions. However, the primary factors are elevated ambient temperatures in combination with fluid loss. Because heat stress is one of the more common health concerns that may be encountered during field activities, employees must be familiar with the signs, symptoms, and various treatment methods of each form of heat stress. Heat stroke is the most serious heat-related illness—it is a threat to life and has a 20 percent mortality rate. Direct exposure to sun, poor air circulation, poor physical condition, and advanced age directly affect the tendency to heat stroke. Table 1 lists the most serious heat conditions, their causes, signs and symptoms, and treatment.

Training is an important component of heat stress prevention. Employees are instructed to recognize and treat heat-related illnesses during 8-hour health and safety refresher and first aid training courses. When working in hot environments, specific steps should be taken to lessen the chances of heat-related illnesses. These include the following:

- Ensuring that all employees drink plenty of fluids (Gatorade® or its equivalent)
- Ensuring that frequent breaks are scheduled so overheating does not occur
- Revising work schedules, when necessary, to take advantage of the cooler parts of the day (such as working from 5:00 a.m. to 11:00 a.m. and 6:00 p.m. to nightfall).

When PPE must be worn (especially Levels A and B), suggested guidelines relating to ambient temperature and maximum wearing time per excursion are as shown in Table 2.

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TABLE 1

HEAT STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles • Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness • Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 105 or 106 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions

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TABLE 2

SUGGESTED GUIDELINES WHEN WEARING PPE

Ambient Temperature	Maximum PPE Wearing Time per Excursion
Above 90 °F	15 minutes
85 to 90 °F	30 minutes
80 to 85 °F	60 minutes
70 to 80 °F	90 minutes
60 to 70 °F	120 minutes
50 to 60 °F	180 minutes

Source: National Institute for Occupational Safety and Health (NIOSH). 1985. Memorandum Regarding Recommended Personal Protective Equipment Wearing Times at Different Temperatures. From Austin Henschel. To Sheldon Rabinovitz. June 20.

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To monitor the level of an employee's heat stress, the following should be measured:

- Heart Rate: Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period; if heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next period, shorten the following work cycle by one-third.

- Oral Temperature: Use a clinical thermometer (3 minutes under the tongue) to measure the oral temperature at the end of the work period. If oral temperature exceeds 99.6 °F (37.6 °C), shorten the next work cycle by one-third without changing the rest period. If oral temperature still exceeds 99.6 °F at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear impermeable PPE when his or her oral temperature exceeds 100.6 °F (38.1 °C).

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SAFE WORK PRACTICES (SWP)

COLD STRESS

SWP NO.: 6-16

ISSUE DATE: JULY 1998

REVISION NO.: 1

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COLD STRESS

This safe work practices (SWP) describes situations where cold stress is likely to occur and discusses procedures for the prevention and treatment of cold-related injuries and illnesses. Cold conditions may present health risks to employees during field activities. The two primary factors that influence the risk potential for cold stress are temperature and wind velocity. Wetness can also contribute to cold stress. Other factors that increase susceptibility to cold stress include age (very young or old), smoking, alcohol consumption, fatigue, and wet clothing. Hypothermia can occur at temperatures above freezing if the individual has on wet or damp clothing or is immersed in cold water. The combined effect of temperature and wind can be evaluated using a wind chill index as shown in Table 1.

Bare flesh and body extremities that have high surface area-to-volume ratios such as fingers, toes, and ears are most susceptible to wind chill or extremely low ambient temperatures. Because cold stress can create the potential for serious injury or death, employees must be familiar with the signs and symptoms and various treatments for each form of cold stress. Table 2 provides information on frostbite and hypothermia, the two most common forms of cold-related injuries.

Training is an essential component of cold stress prevention. Employees are instructed to recognize and treat cold-related injuries during 8-hour health and safety refresher and first aid training courses. When working in cold environments, specific steps should be taken to lessen the chances of cold-related injuries. These include the following:

- Protecting of exposed skin surfaces with appropriate clothing (such as face masks, handwear, and footwear) that insulates, stays dry, and blocks wind
- Shielding the work area with windbreaks to reduce the cooling effects of wind
- Providing equipment for keeping workers' hands warm by including warm air jets and radiant heaters in addition to insulated gloves
- Using adequate insulating clothing to maintain a body core temperature of above 36 °C
- Providing extra insulating clothing on site

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TABLE 1

COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE

Estimated Wind Speed (in miles per hour - mph)	**Actual Temperature Reading (°F)**											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
CALM	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	*LITTLE DANGER* in less than 1 hour with dry skin; maximum danger from false sense of security				*INCREASING DANGER* from freezing of exposed flesh within 1 minute				*GREAT DANGER* that flesh may freeze within 30 seconds			
Trench foot may occur at any point on this chart.												

Source: Modified from American Conference of Governmental Industrial Hygienists. 1997. "Threshold Limit Values for Chemical Substances and Physical Agents."

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TABLE 2

COLD STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) - skin is blanched or whitened and feels hard on the surface • Moderate frostbite - large blisters • Deep frostbite - tissues are cold, pale, and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water—not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

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- Reducing the duration of exposure to cold
- Changing wet or damp clothing as soon as possible

During periods of extreme cold (10 °F or less) workers should use the buddy system to ensure constant protective observation.

Specific monitoring criteria are not established for cold stress. However, employees should be thoroughly cognizant of the signs and symptoms of frostbite and hypothermia (see Table 1) in themselves as well as in coworkers. All instances of cold stress should be reported to the site safety coordinator. Work schedules may be adjusted and warm-up regimes imposed as needed to deal with temperature and wind conditions.

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TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

RESPIRATOR CLEANING PROCEDURES

SWP NO.: 6-27

ISSUE DATE: FEBRUARY 1999

REVISION: 0

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RESPIRATOR CLEANING PROCEDURES

This safe work practice (SWP) provides guidelines for proper and thorough cleaning of respiratory protection equipment. The Occupational Safety and Health Administration (OSHA) regulates the use of respiratory protection for general industry in Title 29 of the *Code of Federal Regulations* (CFR) Part 1910.134, "Respiratory Protection." Appendix B-2 of the standard outlines mandatory requirements for respirator cleaning and is used as the basis for this SWP. This SWP supplements Document Control No. 2-6, "Respiratory Protection Program." It provides specific respirator cleaning and disinfection procedures and shall be included as an attachment to the site-specific health and safety plan for projects for which respirator use is planned or is a contingency.

1.0 APPLICABILITY

This SWP shall apply to any project that involves use of respirators with reusable facepieces.

Respirators shall be cleaned and disinfected as discussed below.

- Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition.
- Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals.
- Respirators maintained for emergency use shall be cleaned and disinfected after each use.
- Respirators used in fit testing and training shall be cleaned and disinfected after each use.

2.0 CLEANING AND DISINFECTION PROCEDURES

Mandatory respirator cleaning procedures as defined in 29 CFR Part 1910.134, Appendix B-2, are listed below. All wash and rinse water should be warm, with a maximum temperature of 110 °F (43 °C).

1. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure-demand valve assemblies, hoses, and any other components as recommended by the manufacturer. Discard or repair any defective parts.

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2. Wash components in warm water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.

3. Rinse components thoroughly in clean, warm, preferably running water. Drain all components.

4. When the cleaner does not contain a disinfecting agent, respirator components should be immersed for 2 minutes in one of the following:

   - Hypochlorite solution [50 parts per million (ppm) of chlorine] made by adding approximately one milliliter of laundry bleach to 1 liter of warm water

   - Aqueous solution of iodine [50 ppm iodine made by adding approximately 0.8 milliliter of tincture of iodine (6 to 8 grams ammonium and/or potassium iodide per 100 cubic centimeters of 45 percent alcohol) to 1 liter of warm water]

   - Other commercially available cleansers of equivalent disinfectant quality when used as directed if their use is recommended or approved by the respirator manufacturer

5. Rinse components thoroughly in clean, warm, preferably running water. Drain all components. The importance of thorough rinsing cannot be over emphasized. Detergents or disinfectants that dry on facepieces may cause dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.

6. Components should be air-dried or hand-dried with a clean, lint-free cloth.

7. Reassemble the facepiece. Replace filters, cartridges, and canisters prior to next use.

8. Test the respirator to ensure that all components work properly.

9. Place the respirator in a clean bag and seal for storage.

Depending on work conditions, respirator facial sealing surfaces may need periodic cleaning during the course of daily use. Cleaning of the facial sealing surface during work breaks can reduce the chance of facial irritation caused by sweat, natural skin oil, or irritating materials that may have deposited on the facepiece. Facial sealing surfaces can be cleaned using disinfectant wipes soaked in isopropyl alcohol or benzalkonium chloride. After use of the disinfectant wipe, the sealing surface should air dry or be dried thoroughly using paper towels or tissues.

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TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

SAFE WORK PRACTICES FOR USE OF AIR PURIFYING RESPIRATORS

SWP NO.: 6-28

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Disclaimer: This safe work practice (SWP) is the property of Tetra Tech, Inc. (Tetra Tech), and its subsidiaries. Any reuse of the SWP without Tetra Tech's permission is at the sole risk of the user. The user will hold harmless Tetra Tech for any damages that result from unauthorized reuse of this SWP. Authorized users are responsible for obtaining proper training and qualification from their employer before performing operations described in this SWP.

SAFE WORK PRACTICES FOR USE OF RESPIRATORS

This safe work practice (SWP) was developed to ensure the proper use of respirators in routine and foreseeable emergency situations. The SWP supplements Document Control No. 2-6, "Respiratory Protection Program." This SWP shall be included as an attachment to the site-specific health and safety plan (HASP) for projects for which respirator use is planned or is a contingency.

1.0 APPLICABILITY

This SWP shall apply to any project that involves use of air purifying respirators and shall not be used for situations involving the use of supplied air systems such as self-contained breathing apparatuses and air-line apparatuses.

2.0 ROUTINE RESPIRATOR USE PROCEDURES

The procedures below apply to the routine use of air purifying respirators.

- Respirators shall not be issued to or worn by individuals when conditions prevent valve function or a good facial seal. These conditions may include but are not limited to facial hair, such as the growth of beard, sideburns, or excessive mustaches, and possibly the wearing of corrective eyeglasses.
- If spectacles, goggles, face shields, or welding helmets must be worn with a facepiece, they will be worn so as not to adversely affect the seal of the facepiece to the face.
- For all tight-fitting respirators, a positive and negative pressure seal check shall be performed each time the respirator is donned. Seal checks shall be performed as follow:
  - *Negative pressure check:* Close off the inlet opening of the canister or cartridge(s) by covering it with the palm of the hand(s), inhale gently so that the facepiece collapses slightly, and hold the breath for 10 seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is satisfactory.
  - *Positive pressure check*: Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. The exhalation valve cover may have to be removed to perform this procedure.

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- *Manufacturer's recommended seal check*: If the respirator manufacturer recommends specific procedures for performing a user seal check, these procedures may be used instead of the negative and positive pressure checks.

- Work areas must be monitored for conditions that may adversely affect the effectiveness of respiratory protection. Employees may leave the work area where respirators are required under the following conditions:

  - To wash the face and respirator facepieces as necessary to prevent eye or skin irritation

  - If vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece is detected

  - To replace the respirator or the filter, cartridge, or canister elements

  - If established monitoring instrument action levels are exceeded

  - For any other criteria as established in a project specific health and safety plan

3.0 RESPIRATOR USE DURING EMERGENCY SITUATIONS

Emergency situations may arise during the wearing of respiratory protection. These situations could include medical emergency, respirator failure, fire, chemical spills or leaks, and other events that pose an immediate risk. Procedures for respirator use during emergency situations are summarized below.

- When an emergency situation arises that creates or has the potential to create immediately dangerous to life and health (IDLH) conditions, the work environment shall be evacuated immediately and shall not be reentered by employees without suitable protective gear.

- Work environments with the potential for the development of atmospheres that may present IDLH conditions shall only be entered by employees using the buddy system.

- When an emergency situation arises that includes physical hazards that may interfere with the proper use of respiratory protection, the work environment shall be evacuated.

- Under no circumstances shall respirator users remove facepieces in hazardous atmospheres. In the event of respirator malfunction, users should leave the hazardous environment immediately and proceed to a known safe location before removal of the facepiece.

- Episodes of respirator failure shall be thoroughly investigated before work activities begin again. The investigation shall include re-evaluation of work area atmospheric

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conditions, review of the respirator selection criteria and service life calculations, and an evaluation of the working conditions under which respirator failure occurred.

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TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

RESPIRATOR QUALITATIVE FIT TESTING PROCEDURES

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RESPIRATOR QUALITATIVE FIT TESTING PROCEDURES

The safe work practice (SWP) addresses the need for proper and thorough procedures for qualitative fit testing of respirators. The Occupational Safety and Health Administration (OSHA) regulates general industrial use of respiratory protection under Title 29 of the *Code of Federal Regulations* (CFR), Part 1910.134. Appendix A of the standard outlines mandatory procedures to use for both qualitative fit tests (QLFT) and quantitative fit tests (QNFT). This SWP was written to meet the requirements of Appendix A for QLFTs. This SWP must be used in conjunction with the Tetra Tech, Inc. (Tetra Tech), "Respiratory Protection Program," Document Control No. 2-6.

The following sections describe the SWP's applicability, qualifications of fit testers, and fit testing procedures for use during QLFTs.

1.0 APPLICABILITY

This SWP applies to all Tetra Tech employees who use respirators on the job and to employees who conduct any fit testing. In addition, when a Tetra Tech company or office uses an outside service to perform fit testing, the organization conducting the fit testing shall meet the minimum requirements for QLFT and QNFT procedures specified in Appendix A of the standard.

Respirator fit testing shall be conducted at the following intervals:

- Prior to initial use of a respirator
- Whenever a different respirator facepiece (size, style, model, or make) is used
- At least annually thereafter
- After any reported or observed changes in an employee's physical condition that could affect respirator fit. This includes but is not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

If an employee notices that the fit of a respirator has become unacceptable, he or she will be given an opportunity to select another respirator facepiece.

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2.0 QUALIFICATION OF FIT TESTERS

Tetra Tech employees who conduct QLFTs must demonstrate sufficient understanding and expertise in the required testing procedures. Fit testers shall qualify through appropriate education, experience, or both. Qualifications of fit testers shall be determined on a case-by-case basis by regional health and safety representatives (RHSR) or subsidiary health and safety representatives (SHSR) based on the fit tester's demonstrated knowledge of OSHA-mandated fit test procedures and performance of a simulated fit test. The RHSR or SHSR must ensure that persons administering fit tests are able to prepare test solutions, calibrate and operate equipment, perform tests properly, recognize invalid tests, and ensure that test equipment is in proper working order. The fit tester must also demonstrate how to clean and maintain equipment to operate within the parameters for which it was designed.

3.0 FIT TESTING PROCEDURES

Appendix A of 29 CFR 1910.134 provides instruction for five OSHA-accepted QLFT procedures. Tetra Tech has selected two of these procedures for its fit test program. The sections below describe general requirements that must be followed during all fit tests and for any fit test method used. Both the Bitrex™ and irritant smoke QLFT protocols are discussed below.

3.1 GENERAL REQUIREMENTS

QLFTs must be conducted in accordance with the general requirements discussed below.

- The test subject shall be shown how to put on a respirator, position it on the face, set strap tension, and determine an acceptable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning the facepiece.
- The test subject must be allowed to choose from a sufficient selection of models and sizes to identify a respirator that fits correctly and is comfortable. The subject shall be informed that he or she is being asked to select the respirator that provides the most acceptable fit. The subject shall be asked to hold each chosen facepiece up to the face and eliminate those that obviously do not provide an acceptable fit.
- The subject shall don the most comfortable respirator and wear it for at least 5 minutes to assess comfort. If the subject is not familiar with a particular respirator, the subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper strap tension.

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- The tester shall review the following points with the subject and allow the subject adequate time to determine the comfort of the respirator:
  - Position of the mask on the nose
  - Room for eye protection
  - Ability to talk
  - Position of the mask on the face and cheeks
- The following criteria shall be used to help determine the adequacy of the respirator fit:
  - Chin properly placed
  - Adequate strap tension (not overly tight)
  - Fit across nose bridge
  - Proper size to span distance from nose to chin
  - Tendency of respirator to slip
  - Self-observation in a mirror to evaluate fit and respirator position
- The subject shall conduct a user seal check using the negative- and positive-pressure seal check procedures described in Appendix A of this SWP. Before conducting the check, the subject shall be instructed to seat the mask on the face by moving the head from side to side and up and down slowly while taking a few slow, deep breaths. If the seal checks fail, the subject shall choose another facepiece.
- Seal checks and fit testing shall not be conducted if there is any facial hair growth such as stubble beard growth, beard, mustache, or sideburns that interferes with the facepiece sealing surface. Any interfering apparel shall be altered or removed.
- If the subject experiences difficulty in breathing during testing, the testing shall stop immediately and he or she shall be referred to a company physician for assessment.
- If the subject finds the fit of the respirator unacceptable, the subject shall be given the opportunity to select a different respirator and to be retested.
- Prior to commencement of the fit test, the subject shall be given a written description of the respirator user seal check procedures (see Appendix A) and exercises to perform during the testing. Exercises and a prepared text to be read during the test are included in Appendix B of this SWP.
- All exercises in Appendix B must be performed for all QLFT methods.

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3.2 BITREX™ SOLUTION QUALITATIVE FIT TEST PROTOCOL

Bitrex™ solution (denatonium benzoate) is a taste aversion agent. To conduct a QLFT using Bitrex™, the test subject must first pass a taste threshold screening. The entire procedure must be explained to the test subject before the screening is conducted. The sections below describe taste threshold screening and fit test procedures. Particulate filters (cartridges) are used during this test.

3.2.1 Taste Threshold Screening

The taste threshold screening is intended to determine whether the individual tested can detect the taste of Bitrex™. The procedures below shall be used for the taste screening.

- Prior to testing, the tester shall prepare a quantity of threshold check solution by adding 13.5 milligrams (mg) of Bitrex™ to 100 milliliters (mL) of 5 percent salt solution in distilled water. A nebulizer for taste screening shall be clearly marked to distinguish it from the fit test solution nebulizer. The taste screening nebulizer shall be thoroughly rinsed in water, shaken to dry, and refilled at least each morning and afternoon or at least every 4 hours.

- During the taste screening as well as during the fit testing, subjects shall wear an enclosure around the head and shoulders that is approximately 12 inches in diameter by 14 inches tall. The front portion of the enclosure shall be clear from the respirator and allow free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts #14 and #15 combined, is adequate.

- The test enclosure shall have a 0.75-inch hole in front of the test subject's nose and month area to accommodate the nebulizer nozzle.

- The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his or her slightly open mouth with tongue extended. The subject is instructed to report when he or she detects a bitter taste.

- Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. To produce the aerosol, the nebulizer bulb is firmly squeezed so that the bulb collapses completely. The bulb is then released and allowed to fully expand. Correct use of the nebulizer means that approximately 1 mL of liquid is used at a time in the nebulizer body.

- The nebulizer should be rapidly squeezed 10 times and then the test subject is asked whether the Bitrex™ solution can be tasted. If the subject reports tasting the bitter taste during the 10 squeezes, the screening test is complete. The taste threshold is noted as 10 regardless of the number of squeezes actually completed.

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- If the first response is negative, the nebulizer is rapidly squeezed 10 more times and the test subject is again asked whether the Bitrex™ solution is tasted. If the test subject reports tasting the bitter taste during the second 10 squeezes, the screening test is completed. The taste threshold is noted as 20 regardless of the number of squeezes actually completed.

- If the second response is negative, the nebulizer is rapidly squeezed 10 more times and the test subject is again asked whether the Bitrex™ solution is tasted. If the test subject reports tasting the bitter taste during the third 10 squeezes, the screening test is completed. The taste threshold is noted as 30 regardless of the number of squeezes actually completed.

- If the Bitrex™ solution is not tasted after 30 squeezes, the test subject is unable to taste the Bitrex™ solution and cannot be fit tested using the Bitrex™ solution test.

- The tester will note the number of squeezes required to solicit a taste response. When a taste response has been elicited, the test subject shall be asked to note the taste for reference in the fit test.

3.2.2 Bitrex™ Solution Fit Test Procedures

The procedures below must be followed to conduct the actual Bitrex™ solution fit test:

- A fit test solution is prepared by adding 337.5 mg of Bitrex™ to 200 mL of a 5 percent salt solution in warm water. A second nebulizer dedicated to fit testing shall be clearly marked to distinguish it from the taste screening solution nebulizer. The nebulizer shall be thoroughly rinsed in water, shaken to dry, and refilled at least each morning and afternoon or at least every 4 hours.

- The test subject shall be instructed not to each, drink, smoke, or chew gum for 15 minutes before the test.

- The person being fit tested shall don the respirator without assistance and perform the required user seal check (see Appendix A).

- The fit test uses the same enclosure described for taste threshold screening in Section 3.2.1. The test subject shall don the enclosure while wearing the respirator selected as described in the general requirements in Section 3.1. The respirator shall be properly adjusted and equipped with particulate filter(s).

- As before, the test subject shall breathe through his or her slightly opened mouth with tongue extended, and shall be instructed to report is he or she tastes the bitter taste of Bitrex™

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- The nebulizer is inserted into the hole in front of the enclosure, and an initial concentration of the fit test solution is sprayed into the enclosure using the same number of squeezes (either 10, 20, or 30) based on the number of squeezes required to elicit taste response noted during the screening test.

- After generating the aerosol, the test subject shall be instructed to perform the test exercises provided in Appendix B.

- Every 30 seconds, the aerosol concentration shall be replenished using one half the number of squeezes used initially (such as 5, 10, or 15).

- The test subject shall indicate to the tester if at any time during the fit test the taste of Bitrex™ solution is detected. If the test subject does not report tasting the Bitrex™ solution, the test is passed.

- If the taste of Bitrex™ solution is detected, the fit is deemed unsatisfactory and the test is failed. A different respirator shall be tried, and the entire test procedure (screening and test) is repeated.

3.3 IRRITANT SMOKE (STANNIC CHLORIDE) QUALITATIVE FIT TEST PROTOCOL

This QLFT uses a person's response to irritating chemicals released in the "smoke" produced by a stannic chloride ventilation smoke tube to detect leakage into the respirator. To conduct this QLFT, the general requirements and precautions, a sensitivity screening check, and fit test procedures discussed below must be followed.

3.3.1 General Requirements and Precautions

General requirements and precautions related to the irritant smoke QLFT are discussed below.

- The respirator to be tested shall be equipped with high-efficiency particulate air (HEPA) or P100 series filter(s). Tetra Tech recommends that the person performing the fit test also wear a full-face respirator with HEPA or P100 series filters.

- Only stannic chloride smoke tubes shall be used for this protocol.

- No test enclosure or hood for the test subject shall be used.

- The smoke can irritate the eyes, lungs, and nasal passages. The test conductor shall take precautions to minimize the test subject's exposure to irritant smoke. Sensitivity varies, and certain individuals may respond to a greater degree to irritant smoke. Care shall be

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taken when performing the sensitivity screening checks that only the minimum amount of smoke is used necessary to elicit a response from the test subject.

- The fit test shall be performed in an area with adequate ventilation to prevent exposure of the person conducting the fit test or buildup of irritant smoke in the general atmosphere.

3.3.2 Sensitivity Screening Check

The person to be tested must demonstrate his or her ability to detect a weak concentration of the irritant smoke as discussed below.

- The tester shall break both ends of a ventilation smoke tube containing stannic chloride and attach one end of the smoke tube to (1) a low-flow air pump set to deliver 200 mL per minute or (2) an aspirator squeeze bulb. The test operator shall cover the other end of the smoke tube with a short piece of tubing to prevent potential injury from the jagged end of the smoke tube.

- The test operator shall advise the test subject that the smoke can be irritating to the eyes, lungs, and nasal passages and instruct the subject to keep his or her eyes closed while the test is performed.

- The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its irritating properties and to determine if he or she can detect the irritating properties of the smoke. The test operator shall carefully direct a small amount of the irritant smoke in the test subject's direction to determine if he or she can detect it.

3.3.3 Irritant Smoke Fit Test Procedures

The procedures below must be followed to conduct the actual irritant smoke fit test.

- The person being fit tested shall don the respirator without assistance and perform the required user seal check (see Appendix A).

- The test subject shall be instructed to keep his or her eyes closed.

- The tester shall direct the stream of irritant smoke from the smoke tube toward the face seal area of the test subject using the low-flow pump or squeeze bulb at least 12 inches from the facepiece. The tester shall move the smoke stream around the whole perimeter of the mask. The tester shall gradually make two more passes around the perimeter of the mask, moving to within 6 inches of the respirator.

- If the person being tested does not have an involuntary response or detect the irritant smoke, the test should proceed with the test exercises provided in Appendix B.

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- The test exercises shall be performed by the test subject while the respirator seal is being continually challenged by the smoke around the perimeter of the respirator at a distance of 6 inches.

- If the person being fit tested reports detecting the irritant smoke at any time, the fit test is failed. The person being retested must repeat the entire sensitivity check and fit test procedure.

- Each test subject passing the irritant smoke test without evidence of a response is required to undergo a second sensitivity screening check after the respirator has been removed using the smoke from the same smoke tube used during the fit test to determine whether he or she still reacts to the smoke. Failure to evoke a response shall render the fit test void. If the subject responds during the second sensitivity check, the fit test is passed.

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APPENDIX A

RESPIRATOR USER SEAL CHECK PROCEDURES

APPENDIX A

RESPIRATOR USER SEAL CHECK PROCEDURE

Individuals using tight-fitting respirators must perform a user seal check each time a respirator is put on to ensure that an adequate seal is achieved. Two methods are available for use; one is the positive- and negative-pressure check and the other is the respirator manufacturer's method. Either the positive- and negative-pressure checks described below may be used or, if a manufacturer of a particular respirator brand has developed its own recommended seal check method, that method may be used in place of the negative- and positive-pressure seal checks. User seal checks are not a substitute for qualitative or quantitative fit tests. The user check procedures described below are as described in the mandatory Appendix B-1 of Title 29 of the *Code of Federal Regulations*, Part 1910.134.

- Positive-Pressure Check

  Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators, this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replace it after the test.

- Negative-Pressure Check

  Close off the inlet opening(s) of the canister or cartridge(s) by covering the opening with the palm of the hand(s) or by replacing the filter seal(s). Inhale gently so that the facepiece collapses slightly, and hold the breath for 10 seconds. The inlet opening of some cartridges cannot be effectively covered with the palm of the hand. In this case, the test can be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

APPENDIX B

RESPIRATOR FIT TEST EXERCISES

RESPIRATOR FIT TEST EXERCISES

Test subjects shall perform the exercises below during fit test process. Prior to the actual fit test, the test subject shall (1) select a suitable and comfortable respirator; (2) don, adjust, and then wear the respirator for 5 minutes to assess comfort; (3) conduct a user seal check in accordance with the procedures outlined in Appendix A, (4) report any difficulties breathing while wearing the respirator, (5) select a different respirator if the fit and level of comfort is unacceptable, and (6) perform the fit test exercises described below in the order listed. The qualitative fit test (QLFT) shall be performed in a test environment.

Test Exercises

Each exercises below shall be conducted for 1 minute. During testing, the subject will be questioned and observed to determine if the respirator is comfortable. The respirator shall not be adjusted during the fit testing procedure. Any adjustment voids the test, and the test must be repeated from the beginning.

1. **Normal breathing.** In a normal standing position without talking, breathe normally.
2. **Deep breathing.** In a normal standing position, breathe slowly and deeply. Be careful not to hyperventilate.
3. **Turning head from side to side.** Standing in place, slowly turn the head from side to side between the extreme positions on each side. Hold the head at each extreme momentarily and inhale at each side.
4. **Moving head up and down**. Standing in place, slowly move the head up and down. Inhale in the up position (such as when looking toward the ceiling).
5. **Talking.** Talk out loud slowly and loud enough to be heard clearly by the fit tester. Read the entire "Rainbow Passage" on the next page.
6. **Bending over.** Bend at the waist as if to touch the toes.
7. **Normal breathing.** Complete the same exercise as item 1 above.

After these test exercises are completed, the tester shall ask the test subject about the comfort of the respirator. If the respirator is uncomfortable, another respirator shall be tried and the fit test, as well as user check and screening procedures, will be repeated.

RAINBOW PASSAGE

"When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow."

Source: Appendix A of Title 29 of the *Code of Federal Regulations,* Part 1910.134

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX C

ATTIC INSPECTION STANDARD OPERATING PROCEDURE

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX D

RESPIRATORY HAZARD ASSESSMENT (FORM RP-2)

(Two Sheets)

Note: This assessment form will be finalized if gasses or vapors are encountered and is not required for asbestos sampling.

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX E

NIOSH ANALYTICAL METHOD 7400

ASBESTOS and OTHER FIBERS by PCM 7400

Various MW: Various CAS: Various RTECS: Various

METHOD: 7400, Issue 2 **EVALUATION: FULL** **Issue 1: Rev. 3 on 15 May 1989**
Issue 2: 15 August 1994

OSHA : 0.1 asbestos fiber (> 5 µm long)/cc; 1 f/cc/30 min excursion; carcinogen
MSHA: 2 asbestos fibers/cc
NIOSH: 0.1 f/cc (fibers > 5 µm long)/400 L; carcinogen
ACGIH: 0.2 crocidolite; 0.5 amosite; 2 chrysotile and other asbestos, fibers/cc; carcinogen

PROPERTIES: solid, fibrous, crystalline, anisotropic

SYNONYMS [CAS #]: actinolite **[77536-66-4]** or ferroactinolite **[15669-07-5]**; amosite **[12172-73-5]**; anthophyllite **[77536-67-5]**; chrysotile **[12001-29-5]**; serpentine **[18786-24-8]**; crocidolite **[12001-28-4]**; tremolite **[77536-68-6]**; amphibole asbestos **[1332-21-4]**; refractory ceramic fibers **[142844-00-6]**; fibrous glass.

SAMPLING

SAMPLER: FILTER (0.45- to 1.2-µm cellulose ester membrane, 25-mm; conductive cowl on cassette)

FLOW RATE*: 0.5 to 16 L/min

VOL-MIN*: 400 L @ 0.1 fiber/cc
-MAX*: (step 4, sampling)
*Adjust to give 100 to 1300 fiber/mm^2

SHIPMENT: routine (pack to reduce shock)

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: 80 to 100 fibers counted

BIAS: See EVALUATION OF METHOD

OVERALL PRECISION ($\hat{S}_{rT}$): 0.115 to 0.13 [1]

ACCURACY: See EVALUATION OF METHOD

MEASUREMENT

TECHNIQUE: LIGHT MICROSCOPY, PHASE CONTRAST

ANALYTE: fibers (manual count)

SAMPLE PREPARATION: acetone - collapse/triacetin - immersion

COUNTING RULES: described in previous version of this method as "A" rules [1,3]

EQUIPMENT:
1. positive phase-contrast microscope
2. Walton-Beckett graticule (100-µm field of view) Type G-22
3. phase-shift test slide (HSE/NPL)

CALIBRATION: HSE/NPL test slide

RANGE: 100 to 1300 fibers/mm^2 filter area

ESTIMATED LOD: 7 fibers/mm^2 filter area

PRECISION ($\bar{S}_r$): 0.10 to 0.12 [1]; see EVALUATION OF METHOD

APPLICABILITY: The quantitative working range is 0.04 to 0.5 fiber/cc for a 1000-L air sample. The LOD depends on sample volume and quantity of interfering dust, and is <0.01 fiber/cc for atmospheres free of interferences. The method gives an index of airborne fibers. It is primarily used for estimating asbestos concentrations, though PCM does not differentiate between asbestos and other fibers. Use this method in conjunction with electron microscopy (e.g., Method 7402) for assistance in identification of fibers. Fibers < ca. 0.25 µm diameter will not be detected by this method [4]. This method may be used for other materials such as fibrous glass by using alternate counting rules (see Appendix C).

INTERFERENCES: If the method is used to detect a specific type of fiber, any other airborne fiber may interfere since all particles meeting the counting criteria are counted. Chain-like particles may appear fibrous. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

OTHER METHODS: This revision replaces Method 7400, Revision #3 (date 5/15/89).

REAGENTS:

1. Acetone,* reagent grade.
2. Triacetin (glycerol triacetate), reagent grade.

* See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: field monitor, 25-mm, three-piece cassette with ca. 50-mm electrically conductive extension cowl and cellulose ester filter, 0.45- to 1.2-µm pore size, and backup pad.

   NOTE 1: Analyze representative filters for fiber background before use to check for clarity and background. Discard the filter lot if mean is ≥5 fibers per 100 graticule fields. These are defined as laboratory blanks. Manufacturer-provided quality assurance checks on filter blanks are normally adequate as long as field blanks are analyzed as described below.

   NOTE 2: The electrically conductive extension cowl reduces electrostatic effects. Ground the cowl when possible during sampling.

   NOTE 3: Use 0.8-µm pore size filters for personal sampling. The 0.45-µm filters are recommended for sampling when performing TEM analysis on the same samples. However, their higher pressure drop precludes their use with personal sampling pumps.

   NOTE 4: Other cassettes have been proposed that exhibit improved uniformity of fiber deposit on the filter surface, e.g., bellmouthed sampler (Envirometrics, Charleston, SC). These may be used if shown to give measured concentrations equivalent to sampler indicated above for the application.
2. Personal sampling pump, battery or line-powered vacuum, of sufficient capacity to meet flow-rate requirements (see step 4 for flow rate), with flexible connecting tubing.
3. Wire, multi-stranded, 22-gauge; 1", hose clamp to attach wire to cassette.
4. Tape, shrink- or adhesive-.
5. Slides, glass, frosted-end, pre-cleaned, 25 x 75-mm.
6. Cover slips, 22- x 22-mm, No. 1-1/2, unless otherwise specified by microscope manufacturer.
7. Lacquer or nail polish.
8. Knife, #10 surgical steel, curved blade.
9. Tweezers.

EQUIPMENT:

10. Acetone flash vaporization system for clearing filters on glass slides (see ref. [5] for specifications or see manufacturer's instructions for equivalent devices).
11. Micropipets or syringes, 5-µL and 100- to 500-µL.
12. Microscope, positive phase (dark) contrast, with green or blue filter, adjustable field iris, 8 to 10X eyepiece, and 40 to 45X phase objective (total magnification ca. 400X); numerical aperture = 0.65 to 0.75.
13. Graticule, Walton-Beckett type with 100-µm diameter circular field (area = 0.00785 mm2) at the specimen plane (Type G-22). Available from Optometrics USA, P.O. Box 699, Ayer, MA 01432 [phone (508)-772-1700], and McCrone Accessories and Components, 850 Pasquinelli Drive, Westmont, IL 60559 [phone (312) 887-7100].
    NOTE: The graticule is custom-made for each microscope. (see APPENDIX A for the custom-ordering procedure).
14. HSE/NPL phase contrast test slide, Mark II. Available from Optometrics USA (address above).
15. Telescope, ocular phase-ring centering.
16. Stage micrometer (0.01-mm divisions).

SPECIAL PRECAUTIONS: Acetone is extremely flammable. Take precautions not to ignite it. Heating of acetone in volumes greater than 1 mL must be done in a ventilated laboratory fume hood using a flameless, spark- free heat source.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. To reduce contamination and to hold the cassette tightly together, seal the crease between the cassette base and the cowl with a shrink band or light colored adhesive tape. For personal sampling, fasten the (uncapped) open-face cassette to the worker's lapel. The open face should be oriented downward.
   NOTE: The cowl should be electrically grounded during area sampling, especially under conditions of low relative humidity. Use a hose clamp to secure one end of the wire (Equipment, Item 3) to the monitor's cowl. Connect the other end to an earth ground (i.e., cold water pipe).
3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Handle field blanks in a manner representative of actual handling of associated samples in the set. Open field blank cassettes at the same time as other cassettes just prior to sampling. Store top covers and cassettes in a clean area (e.g., a closed bag or box) with the top covers from the sampling cassettes during the sampling period.
4. Sample at 0.5 L/min or greater [6]. Adjust sampling flow rate, Q (L/min), and time, t (min), to produce a fiber density, E, of 100 to 1300 fibers/mm^2 ($3.85 \cdot 10^4$ to $5 \cdot 10^5$ fibers per 25-mm filter with effective collection area A_c= 385 mm^2) for optimum accuracy. These variables are related to the action level (one-half the current standard), L (fibers/cc), of the fibrous aerosol being sampled by:

$$t = \frac{A_c \cdot E}{Q \cdot L \cdot 10^3}, \text{ min.}$$

NOTE 1: The purpose of adjusting sampling times is to obtain optimum fiber loading on the filter. The collection efficiency does not appear to be a function of flow rate in the range of 0.5 to 16 L/min for asbestos fibers [7]. Relatively large diameter fibers (>3 µm) may exhibit significant aspiration loss and inlet deposition. A sampling rate of 1 to 4 L/min for 8 h is appropriate in atmospheres containing ca. 0.1 fiber/cc in the absence of significant amounts of non-asbestos dust. Dusty atmospheres require smaller sample volumes (≤400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres, where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3000 to 10000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If ≥ 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration.

NOTE 2: OSHA regulations specify a minimum sampling volume of 48 L for an excursion measurement, and a maximum sampling rate of 2.5 L/min [3].

5. At the end of sampling, replace top cover and end plugs.
6. Ship samples with conductive cowl attached in a rigid container with packing material to prevent jostling or damage.
   NOTE: Do not use untreated polystyrene foam in shipping container because electrostatic forces may cause fiber loss from sample filter.

SAMPLE PREPARATION:

NOTE 1: The object is to produce samples with a smooth (non-grainy) background in a medium with refractive index ≤1.46. This method collapses the filter for easier focusing and produces permanent (1 - 10 years) mounts which are useful for quality control and interlaboratory comparison. The aluminum "hot block" or similar flash vaporization techniques may be used outside the laboratory [2]. Other mounting techniques meeting the above criteria may also be used (e.g., the laboratory fume hood procedure for generating acetone vapor as described in Method 7400 - revision of 5/15/85, or the non-permanent field mounting technique used in P&CAM 239 [3,7,8,9]). Unless the effective filtration area is known, determine the area and record the information referenced against the sample ID number [1,9,10,11].

NOTE 2: Excessive water in the acetone may slow the clearing of the filter, causing material to be washed off the surface of the filter. Also, filters that have been exposed to high humidities prior to clearing may have a grainy background.

7. Ensure that the glass slides and cover slips are free of dust and fibers.
8. Adjust the rheostat to heat the "hot block" to ca. 70 °C [2].
   NOTE: If the "hot block" is not used in a fume hood, it must rest on a ceramic plate and be isolated from any surface susceptible to heat damage.
9. Mount a wedge cut from the sample filter on a clean glass slide.
   a. Cut wedges of ca. 25% of the filter area with a curved-blade surgical steel knife using a rocking motion to prevent tearing. Place wedge, dust side up, on slide.
      NOTE: Static electricity will usually keep the wedge on the slide.

b. Insert slide with wedge into the receiving slot at base of "hot block". Immediately place tip of a micropipet containing ca. 250 µL acetone (use the minimum volume needed to consistently clear the filter sections) into the inlet port of the PTFE cap on top of the "hot block" and inject the acetone into the vaporization chamber with a slow, steady pressure on the plunger button while holding pipet firmly in place. After waiting 3 to 5 sec for the filter to clear, remove pipet and slide from their ports.

CAUTION: Although the volume of acetone used is small, use safety precautions. Work in a well-ventilated area (e.g., laboratory fume hood). Take care not to ignite the acetone. Continuous use of this device in an unventilated space may produce explosive acetone vapor concentrations.

c. Using the 5-µL micropipet, immediately place 3.0 to 3.5 µL triacetin on the wedge. Gently lower a clean cover slip onto the wedge at a slight angle to reduce bubble formation. Avoid excess pressure and movement of the cover glass.

NOTE: If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours. If excessive triacetin remains at the edge of the filter under the cover slip, fiber migration may occur.

d. Mark the outline of the filter segment with a glass marking pen to aid in microscopic evaluation.

e. Glue the edges of the cover slip to the slide using lacquer or nail polish [12]. Counting may proceed immediately after clearing and mounting are completed.

NOTE: If clearing is slow, warm the slide on a hotplate (surface temperature 50 °C) for up to 15 min to hasten clearing. Heat carefully to prevent gas bubble formation.

CALIBRATION AND QUALITY CONTROL:

10. Microscope adjustments. Follow the manufacturers instructions. At least once daily use the telescope ocular (or Bertrand lens, for some microscopes) supplied by the manufacturer to ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric. With each microscope, keep a logbook in which to record the dates of microscope cleanings and major servicing.

    a. Each time a sample is examined, do the following:

        (1) Adjust the light source for even illumination across the field of view at the condenser iris. Use Kohler illumination, if available. With some microscopes, the illumination may have to be set up with bright field optics rather than phase contract optics.

        (2) Focus on the particulate material to be examined.

        (3) Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.

    b. Check the phase-shift detection limit of the microscope periodically for each analyst/microscope combination:

        (1) Center the HSE/NPL phase-contrast test slide under the phase objective.

        (2) Bring the blocks of grooved lines into focus in the graticule area.

        NOTE: The slide contains seven blocks of grooves (ca. 20 grooves per block) in descending order of visibility. For asbestos counting the microscope optics must completely resolve the grooved lines in block 3 although they may appear somewhat faint, and the grooved lines in blocks 6 and 7 must be invisible when centered in the graticule area. Blocks 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements has resolution either too low or too high for fiber counting.

        (3) If image quality deteriorates, clean the microscope optics. If the problem persists, consult the microscope manufacturer.

11. Document the laboratory's precision for each counter for replicate fiber counts.

    a. Maintain as part of the laboratory quality assurance program a set of reference slides to be used on a daily basis [13]. These slides should consist of filter preparations including a range of loadings and background dust levels from a variety of sources including both field and reference samples (e.g., PAT, AAR, commercial samples). The Quality Assurance Officer

should maintain custody of the reference slides and should supply each counter with a minimum of one reference slide per workday. Change the labels on the reference slides periodically so that the counter does not become familiar with the samples.

b. From blind repeat counts on reference slides, estimate the laboratory intra- and intercounter precision. Obtain separate values of relative standard deviation (S_r) for each sample matrix analyzed in each of the following ranges: 5 to 20 fibers in 100 graticule fields, >20 to 50 fibers in 100 graticule fields, and >50 to 100 fibers in 100 graticule fields. Maintain control charts for each of these data files.

NOTE: Certain sample matrices (e.g., asbestos cement) have been shown to give poor precision [9]

12. Prepare and count field blanks along with the field samples. Report counts on each field blank.

NOTE 1: The identity of blank filters should be unknown to the counter until all counts have been completed.

NOTE 2: If a field blank yields greater than 7 fibers per 100 graticule fields, report possible contamination of the samples.

13. Perform blind recounts by the same counter on 10% of filters counted (slides relabeled by a person other than the counter). Use the following test to determine whether a pair of counts by the same counter on the same filter should be rejected because of possible bias: Discard the sample if the absolute value of the difference between the square roots of the two counts (in fiber/mm^2) exceeds 2.77 (X)S_r', where X = average of the square roots of the two fiber counts (in fiber/mm^2) and $S_r' = \frac{S_r}{2}$, where S_r is the intracounter relative standard deviation for the appropriate count range (in fibers) determined in step 11. For more complete discussions see reference [13].

NOTE 1: Since fiber counting is the measurement of randomly placed fibers which may be described by a Poisson distribution, a square root transformation of the fiber count data will result in approximately normally distributed data [13].

NOTE 2: If a pair of counts is rejected by this test, recount the remaining samples in the set and test the new counts against the first counts. Discard all rejected paired counts. It is not necessary to use this statistic on blank counts.

14. The analyst is a critical part of this analytical procedure. Care must be taken to provide a non-stressful and comfortable environment for fiber counting. An ergonomically designed chair should be used, with the microscope eyepiece situated at a comfortable height for viewing. External lighting should be set at a level similar to the illumination level in the microscope to reduce eye fatigue. In addition, counters should take 10-to-20 minute breaks from the microscope every one or two hours to limit fatigue [14]. During these breaks, both eye and upper back/neck exercises should be performed to relieve strain.

15. All laboratories engaged in asbestos counting should participate in a proficiency testing program such as the AIHA-NIOSH Proficiency Analytical Testing (PAT) Program for asbestos and routinely exchange field samples with other laboratories to compare performance of counters.

MEASUREMENT:

16. Center the slide on the stage of the calibrated microscope under the objective lens. Focus the microscope on the plane of the filter.

17. Adjust the microscope (Step 10).

NOTE: Calibration with the HSE/NPL test slide determines the minimum detectable fiber diameter (ca. 0.25 µm) [4].

18. Counting rules: (same as P&CAM 239 rules [1,10,11]: see examples in APPENDIX B).

a. Count any fiber longer than 5 µm which lies entirely within the graticule area.

(1) Count only fibers longer than 5 µm. Measure length of curved fibers along the curve.

(2) Count only fibers with a length-to-width ratio equal to or greater than 3:1.

b. For fibers which cross the boundary of the graticule field:

(1) Count as 1/2 fiber any fiber with only one end lying within the graticule area, provided that the fiber meets the criteria of rule a above.

(2) Do not count any fiber which crosses the graticule boundary more than once.
(3) Reject and do not count all other fibers.

c. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of a fiber.
d. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 graticule fields regardless of count.

19. Start counting from the tip of the filter wedge and progress along a radial line to the outer edge. Shift up or down on the filter, and continue in the reverse direction. Select graticule fields randomly by looking away from the eyepiece briefly while advancing the mechanical stage. Ensure that, as a minimum, each analysis covers one radial line from the filter center to the outer edge of the filter. When an agglomerate or bubble covers ca. 1/6 or more of the graticule field, reject the graticule field and select another. Do not report rejected graticule fields in the total number counted.

NOTE 1: When counting a graticule field, continuously scan a range of focal planes by moving the fine focus knob to detect very fine fibers which have become embedded in the filter. The small-diameter fibers will be very faint but are an important contribution to the total count. A minimum counting time of 15 seconds per field is appropriate for accurate counting.

NOTE 2: This method does not allow for differentiation of fibers based on morphology. Although some experienced counters are capable of selectively counting only fibers which appear to be asbestiform, there is presently no accepted method for ensuring uniformity of judgment between laboratories. It is, therefore, incumbent upon all laboratories using this method to report total fiber counts. If serious contamination from non-asbestos fibers occurs in samples, other techniques such as transmission electron microscopy must be used to identify the asbestos fiber fraction present in the sample (see NIOSH Method 7402). In some cases (i.e., for fibers with diameters >1 µm), polarized light microscopy (as in NIOSH Method 7403) may be used to identify and eliminate interfering non-crystalline fibers [15].

NOTE 3: Do not count at edges where filter was cut. Move in at least 1 mm from the edge.

NOTE 4: Under certain conditions, electrostatic charge may affect the sampling of fibers. These electrostatic effects are most likely to occur when the relative humidity is low (below 20%), and when sampling is performed near the source of aerosol. The result is that deposition of fibers on the filter is reduced, especially near the edge of the filter. If such a pattern is noted during fiber counting, choose fields as close to the center of the filter as possible [5].

NOTE 5: Counts are to be recorded on a data sheet that provides, as a minimum, spaces on which to record the counts for each field, filter identification number, analyst's name, date, total fibers counted, total fields counted, average count, fiber density, and commentary. Average count is calculated by dividing the total fiber count by the number of fields observed. Fiber density (fibers/mm^2) is defined as the average count (fibers/field) divided by the field (graticule) area (mm^2/field).

CALCULATIONS AND REPORTING OF RESULTS

20. Calculate and report fiber density on the filter, E (fibers/mm^2), by dividing the average fiber count per graticule field, F/n_f, minus the mean field blank count per graticule field, B/n_b, by the graticule field area, A_f (approx. 0.00785 mm^2):

$$E = \frac{\left(\frac{F}{n_f} - \frac{B}{n_b}\right)}{A_f}, \text{ fibers/mm}^2.$$

NOTE: Fiber counts above 1300 fibers/mm^2 and fiber counts from samples with >50% of filter area covered with particulate should be reported as "uncountable" or "probably biased." Other fiber counts outside the 100-1300 fiber/mm^2 range should be reported as having "greater than optimal variability" and as being "probably biased."

21. Calculate and report the concentration, C (fibers/cc), of fibers in the air volume sampled, V (L), using the effective collection area of the filter, A_c (approx. 385 mm^2 for a 25-mm filter):

$$C = \frac{(E)(A_c)}{V \cdot 10^3}.$$

NOTE: Periodically check and adjust the value of A_c, if necessary.

22. Report intralaboratory and interlaboratory relative standard deviations (from Step 11) with each set of results.

NOTE: Precision depends on the total number of fibers counted [1,16]. Relative standard deviation is documented in references [1,15-17] for fiber counts up to 100 fibers in 100 graticule fields. Comparability of interlaboratory results is discussed below. As a first approximation, use 213% above and 49% below the count as the upper and lower confidence limits for fiber counts greater than 20 (Fig. 1).

EVALUATION OF METHOD:

A. This method is a revision of P&CAM 239 [10]. A summary of the revisions is as follows:

1. Sampling:
   The change from a 37-mm to a 25-mm filter improves sensitivity for similar air volumes. The change in flow rates allows for 2-m^3 full-shift samples to be taken, providing that the filter is not overloaded with non-fibrous particulates. The collection efficiency of the sampler is not a function of flow rate in the range 0.5 to 16 L/min [10].
2. Sample Preparation Technique:
   The acetone vapor-triacetin preparation technique is a faster, more permanent mounting technique than the dimethyl phthalate/diethyl oxalate method of P&CAM 239 [2,4,10]. The aluminum "hot block" technique minimizes the amount of acetone needed to prepare each sample.
3. Measurement:
   a. The Walton-Beckett graticule standardizes the area observed [14,18,19].
   b. The HSE/NPL test slide standardizes microscope optics for sensitivity to fiber diameter [4,14].
   c. Because of past inaccuracies associated with low fiber counts, the minimum recommended loading has been increased to 100 fibers/mm^2 filter area (a total of 78.5 fibers counted in 100 fields, each with field area = .00785 mm^2.) Lower levels generally result in an overestimate of the fiber count when compared to results in the recommended analytical range [20]. The recommended loadings should yield intracounter S_r in the range of 0.10 to 0.17 [21,22,23].

B. Interlaboratory comparability:
An international collaborative study involved 16 laboratories using prepared slides from the asbestos cement, milling, mining, textile, and friction material industries [9]. The relative standard deviations (S_r) varied with sample type and laboratory. The ranges were:

	Intralaboratory S_r	Interlaboratory S_r	Overall S_r
AIA (NIOSH A Rules)*	0.12 to 0.40	0.27 to 0.85	0.46
Modified CRS (NIOSH B Rules)**	0.11 to 0.29	0.20 to 0.35	0.25

* Under AIA rules, only fibers having a diameter less than 3 µm are counted and fibers attached to particles larger than 3 µm are not counted. NIOSH A Rules are otherwise similar to the AIA rules.
** See Appendix C.

A NIOSH study conducted using field samples of asbestos gave intralaboratory S_r in the range 0.17 to 0.25 and an interlaboratory S_r of 0.45 [21]. This agrees well with other recent studies [9,14,16].

At this time, there is no independent means for assessing the overall accuracy of this method. One measure of reliability is to estimate how well the count for a single sample agrees with the mean count from a large number of laboratories. The following discussion indicates how this estimation can be carried out based on measurements of the interlaboratory variability, as well as showing how the results of this method relate to the theoretically attainable counting precision and to measured intra- and interlaboratory S_r. (NOTE: The following discussion does not include bias estimates and should not be taken to indicated that lightly loaded samples are as accurate as properly loaded ones).

Theoretically, the process of counting randomly (Poisson) distributed fibers on a filter surface will give an S_r that depends on the number, N, of fibers counted:

$$S_r = 1/(N)^{1/2} \qquad (1)$$

Thus S_r is 0.1 for 100 fibers and 0.32 for 10 fibers counted. The actual S_r found in a number of studies is greater than these theoretical numbers [17,19,20,21].

An additional component of variability comes primarily from subjective interlaboratory differences. In a study of ten counters in a continuing sample exchange program, Ogden [15] found this subjective component of intralaboratory S_r to be approximately 0.2 and estimated the overall S_r by the term:

$$\frac{[N + (0.2 \cdot N)^2]^{1/2}}{N} \qquad (2)$$

Ogden found that the 90% confidence interval of the individual intralaboratory counts in relation to the means were +2 S_r and - 1.5 S_r. In this program, one sample out of ten was a quality control sample. For laboratories not engaged in an intensive quality assurance program, the subjective component of variability can be higher.

In a study of field sample results in 46 laboratories, the Asbestos Information Association also found that the variability had both a constant component and one that depended on the fiber count [14]. These results gave a subjective interlaboratory component of S_r (on the same basis as Ogden's) for field samples of ca. 0.45. A similar value was obtained for 12 laboratories analyzing a set of 24 field samples [21]. This value falls slightly above the range of S_r (0.25 to 0.42 for 1984-85) found for 80 reference laboratories in the NIOSH PAT program for laboratory-generated samples [17].

A number of factors influence S_r for a given laboratory, such as that laboratory's actual counting performance and the type of samples being analyzed. In the absence of other information, such as from an interlaboratory quality assurance program using field samples, the value for the subjective component of variability is chosen as 0.45. It is hoped that the laboratories will carry out the recommended interlaboratory quality assurance programs to improve their performance and thus reduce the S_r.

The above relative standard deviations apply when the population mean has been determined. It is more useful, however, for laboratories to estimate the 90% confidence interval on the mean count from a single sample fiber count (Figure 1). These curves assume similar shapes of the count distribution for interlaboratory and intralaboratory results [16].

For example, if a sample yields a count of 24 fibers, Figure 1 indicates that the mean interlaboratory count will fall within the range of 227% above and 52% below that value 90% of the time. We can apply these percentages directly to the air concentrations as well. If, for instance, this sample (24 fibers counted) represented a 500-L volume, then the measured concentration is 0.02 fibers/mL (assuming 100 fields counted, 25-mm filter, 0.00785 mm^2 counting field area). If this same sample were counted by a group of laboratories, there is a 90% probability that the mean would fall between 0.01 and 0.08 fiber/mL. These limits should be reported in any comparison of results between laboratories.

Note that the S_r of 0.45 used to derive Figure 1 is used as an estimate for a random group of laboratories. If several laboratories belonging to a quality assurance group can show that their interlaboratory S_r is smaller, then it is more correct to use that smaller S_r. However, the estimated S_r of 0.45 is to be used in the absence of such information. Note also that it has been found that S_r can be higher for certain types of samples, such as asbestos cement [9].

Quite often the estimated airborne concentration from an asbestos analysis is used to compare to a regulatory standard. For instance, if one is trying to show compliance with an 0.5 fiber/mL standard using a single sample on which 100 fibers have been counted, then Figure 1 indicates that the 0.5 fiber/mL standard must be 213% higher than the measured air concentration. This indicates that if one measures a fiber concentration of 0.16 fiber/mL (100 fibers counted), then the mean fiber count by a group of laboratories (of which the compliance laboratory might be one) has a 95% chance of being less than 0.5 fibers/mL; i.e., 0.16 + 2.13 x 0.16 = 0.5.

It can be seen from Figure 1 that the Poisson component of the variability is not very important unless the number of fibers counted is small. Therefore, a further approximation is to simply use +213% and −49% as the upper and lower confidence values of the mean for a 100-fiber count.

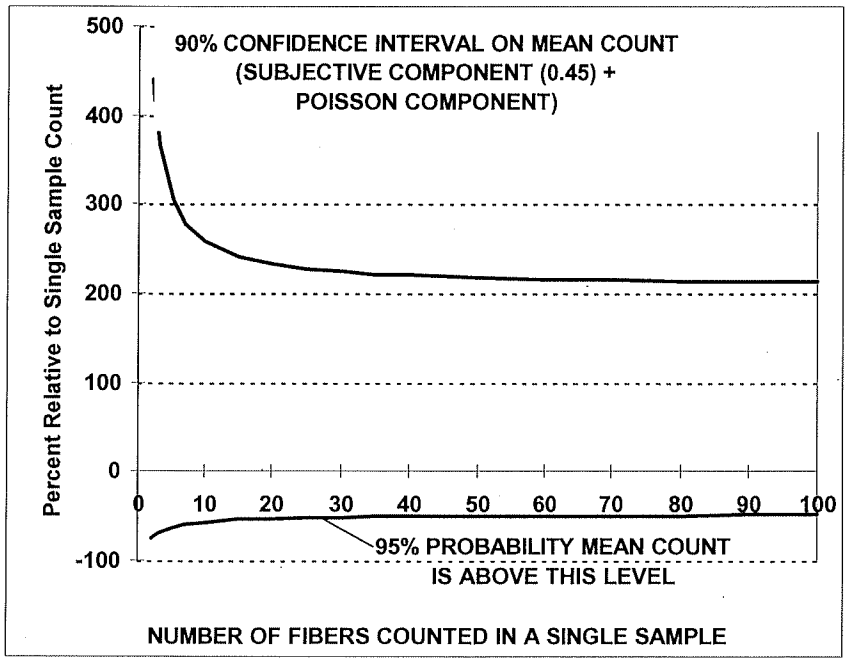

Figure 1. Interlaboratory Precision of Fiber Counts

The curves in Figures 1 are defined by the following equations:

$$UCL = \frac{2X + 2.25 + [(2.25 + 2X)^2 - 4(1 - 2.25 S_r^2) X^2]^{1/2}}{2(1 - 2.25 S_r^2)} \quad (3)$$

$$LCL = \frac{2X + 4 - [(4 + 2X)^2 - 4(1 - 4 S_r^2) X^2]^{1/2}}{2(1 - 4 S_r^2)} \quad (4)$$

where S_r = subjective interlaboratory relative standard deviation, which is close to the total interlaboratory S_r when approximately 100 fibers are counted.
X = total fibers counted on sample
LCL = lower 95% confidence limit.
UCL = upper 95% confidence limit.
Note that the range between these two limits represents 90% of the total range.

REFERENCES:

[1] Leidel, N. A., S. G. Bayer, R. D. Zumwalde, and K. A. Busch. USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 79-127 (1979).

[2] Baron, P. A. and G. C. Pickford. "An Asbestos Sample Filter Clearing Procedure," Appl. Ind. Hyg., 1:169-171, 199 (1986).

[3] Occupational Safety and Health Administration, U.S. Department of Labor, Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite Asbestos; Final Rules, 29 CFR Part 1910.1001 Amended June 20, 1986.

[4] Rooker, S. J., N. P. Vaughn, and J. M. LeGuen. "On the Visibility of Fibers by Phase Contrast Microscopy," Amer. Ind. Hyg. Assoc. J., 43, 505-515 (1982).

[5] Baron, P. and G. Deye, "Electrostatic Effects in Asbestos Sampling," Parts I and II Amer. Ind. Hyg. Assoc. J., 51, 51-69 (1990).

[6] Johnston, A. M., A. D. Jones, and J. H. Vincent. "The Influence of External Aerodynamic Factors on the Measurement of the Airborne Concentration of Asbestos Fibers by the Membrane Filter Method," Ann. Occup. Hyg., 25, 309-316 (1982).

[7] Beckett, S.T., "The Effects of Sampling Practice on the Measured Concentration of Airborne Asbestos," Ann. Occup. Hyg., 21, 259-272 (1980).

[8] Jankovic, J. T., W. Jones, and J. Clere. "Field Techniques for Clearing Cellulose Ester Filters Used in Asbestos Sampling," Appl. Ind. Hyg., 1, 145-147 (1986).

[9] Crawford, N. P., H. L. Thorpe, and W. Alexander. "A Comparison of the Effects of Different Counting Rules and Aspect Ratios on the Level and Reproducibility of Asbestos Fiber Counts," Part I: Effects on Level (Report No. TM/82/23), Part II: Effects on Reproducibility (Report No. TM/82/24), Institute of Occupational Medicine, Edinburgh, Scotland (December, 1982).

[10] NIOSH Manual of Analytical Methods, 2nd ed., Vol. 1., P&CAM 239, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).

[11] Revised Recommended Asbestos Standard, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-169 (1976); as amended in NIOSH statement at OSHA Public Hearing, June 21, 1984.

[12] Asbestos International Association, AIA Health and Safety Recommended Technical Method #1 (RTMI). "Airborne Asbestos Fiber Concentrations at Workplaces by Light Microscopy" (Membrane Filter Method), London (1979).

[13] Abell, M., S. Shulman and P. Baron. The Quality of Fiber Count Data, Appl. Ind. Hyg., 4, 273-285

(1989).
[14] "A Study of the Empirical Precision of Airborne Asbestos Concentration Measurements in the Workplace by the Membrane Filter Method," Asbestos Information Association, Air Monitoring Committee Report, Arlington, VA (June, 1983).
[15] McCrone, W., L. McCrone and J. Delly, "Polarized Light Microscopy," Ann Arbor Science (1978).
[16] Ogden, T. L. "The Reproducibility of Fiber Counts," Health and Safety Executive Research Paper 18 (1982).
[17] Schlecht, P. C. and S. A. Schulman. "Performance of Asbestos Fiber Counting Laboratories in the NIOSH Proficiency Analytical Testing (PAT) Program," Am. Ind. Hyg. Assoc. J., 47, 259-266 (1986).
[18] Chatfield, E. J. Measurement of Asbestos Fiber Concentrations in Workplace Atmospheres, Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario, Study No. 9, 180 Dundas Street West, 22nd Floor, Toronto, Ontario, CANADA M5G 1Z8.
[19] Walton, W. H. "The Nature, Hazards, and Assessment of Occupational Exposure to Airborne Asbestos Dust: A Review," Ann. Occup. Hyg., 25, 115-247 (1982).
[20] Cherrie, J., A.D. Jones, and A.M. Johnston. "The Influence of Fiber Density on the Assessment of Fiber Concentration Using the membrane filter Method." Am. Ind. Hyg. Assoc. J., 47(8), 465-74 (1986).
[21] Baron, P. A. and S. Shulman. "Evaluation of the Magiscan Image Analyzer for Asbestos Fiber Counting." Am. Ind. Hyg. Assoc. J., (in press).
[22] Taylor, D. G., P. A. Baron, S. A. Shulman and J. W. Carter. "Identification and Counting of Asbestos Fibers," Am. Ind. Hyg. Assoc. J. 45(2), 84-88 (1984).
[23] "Potential Health Hazards of Video Display Terminals," NIOSH Research Report, June 1981.
[24] "Reference Methods for Measuring Airborne Man-Made Mineral Fibers (MMMF)," WHO/EURO Technical Committee for Monitoring an Evaluating Airborne MMMF, World Health Organization, Copenhagen (1985).
[25] Criteria for a Recommended Standard...Occupational Exposure to Fibrous Glass, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-152 (1977).

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APPENDIX A: CALIBRATION OF THE WALTON-BECKETT GRATICULE:

Before ordering the Walton-Beckett graticule, the following calibration must be done to obtain a counting area (D) 100 µm in diameter at the image plane. The diameter, d_c (mm), of the circular counting area and the disc diameter must be specified when ordering the graticule.

1. Insert any available graticule into the eyepiece and focus so that the graticule lines are sharp and clear.
2. Set the appropriate interpupillary distance and, if applicable, reset the binocular head adjustment so that the magnification remains constant.
3. Install the 40 to 45X phase objective.
4. Place a stage micrometer on the microscope object stage and focus the microscope on the graduated lines.
5. Measure the magnified grid length of the graticule, L_o (µm), using the stage micrometer.
6. Remove the graticule from the microscope and measure its actual grid length, L_a (mm). This can best be accomplished by using a stage fitted with verniers.
7. Calculate the circle diameter, d_c (mm), for the Walton-Beckett graticule:

$$d_c = \frac{L_a}{L_o} \times D. \qquad (5)$$

Example: If L_o = 112 µm, L_a = 4.5 mm and D = 100 µm, then d_c = 4.02 mm.

8. Check the field diameter, D (acceptable range 100 µm ± 2 µm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine field area (acceptable range 0.00754 mm^2 to 0.00817 mm^2).

APPENDIX B: COMPARISON OF COUNTING RULES:

Figure 2 shows a Walton-Beckett graticule as seen through the microscope. The rules will be discussed as they apply to the labeled objects in the figure.

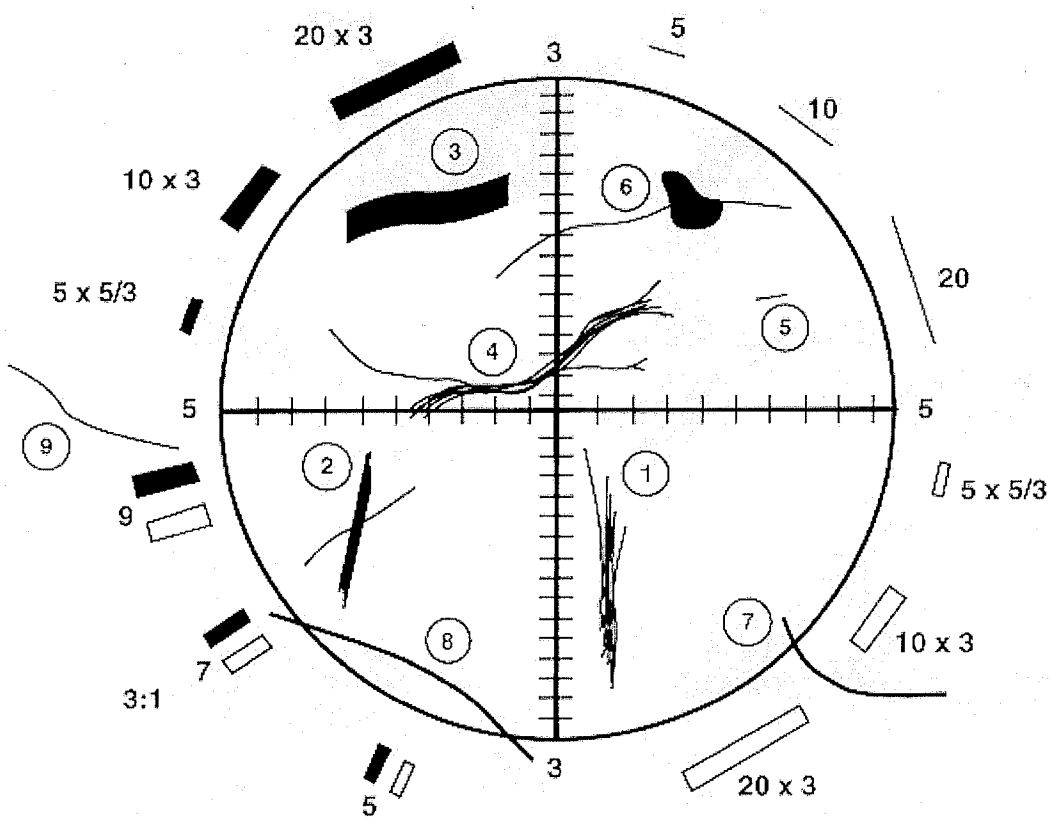


Figure 2. Walton-Beckett graticule with fibers.

These rules are sometimes referred to as the "A" rules.

FIBER COUNT

Object	Count	DISCUSSION
1	1 fiber	Optically observable asbestos fibers are actually bundles of fine fibrils. If the fibrils seem to be from the same bundle the object is counted as a single fiber. Note, however, that all objects meeting length and aspect ratio criteria are counted whether or not they appear to be asbestos.
2	2 fiber	If fibers meeting the length and aspect ratio criteria (length >5 µm and length-to-width ratio >3 to 1) overlap, but do not seem to be part of the same bundle, they are counted as separate fibers.
3	1 fiber	Although the object has a relatively large diameter (>3 µm), it is counted as fiber under the rules. There is no upper limit on the fiber diameter in the counting rules. Note that fiber width is measured at the widest compact section of the object.
4	1 fiber	Although long fine fibrils may extend from the body of a fiber, these fibrils are considered part of the fiber if they seem to have originally been part of the bundle.
5	Do not count	If the object is ≤5 µm long, it is not counted.
6	1 fiber	A fiber partially obscured by a particle is counted as one fiber. If the fiber ends emanating from a particle do not seem to be from the same fiber and each end meets the length and aspect ratio criteria, they are counted as separate fibers.
7	1/2 fiber	A fiber which crosses into the graticule area one time is counted as 1/2 fiber.
8	Do not count	Ignore fibers that cross the graticulate boundary more than once. count
9	Do not count	Ignore fibers that lie outside the graticule boundary.

APPENDIX C. ALTERNATE COUNTING RULES FOR NON-ASBESTOS FIBERS

Other counting rules may be more appropriate for measurement of specific non-asbestos fiber types, such as fibrous glass. These include the "B" rules given below (from NIOSH Method 7400, Revision #2, dated 8/15/87), the World Health Organization reference method for man-made mineral fiber [24], and the NIOSH fibrous glass criteria document method [25]. The upper diameter limit in these methods prevents measurements of non-thoracic fibers. It is important to note that the aspect ratio limits included in these methods vary. NIOSH recommends the use of the 3:1 aspect ratio in counting fibers.

It is emphasized that hybridization of different sets of counting rules is not permitted. Report specifically which set of counting rules are used with the analytical results.

"B" COUNTING RULES:

1. Count only ends of fibers. Each fiber must be longer than 5 µm and less than 3 µm diameter.
2. Count only ends of fibers with a length-to-width ratio equal to or greater than 5:1.
3. Count each fiber end which falls within the graticule area as one end, provided that the fiber meets rules 1 and 2 above. Add split ends to the count as appropriate if the split fiber segment also meets the criteria of rules 1 and 2 above.
4. Count visibly free ends which meet rules 1 and 2 above when the fiber appears to be attached to another particle, regardless of the size of the other particle. Count the end of a fiber obscured by another particle if the particle covering the fiber end is less than 3 µm in diameter.
5. Count free ends of fibers emanating from large clumps and bundles up to a maximum of 10 ends (5 fibers), provided that each segment meets rules 1 and 2 above.
6. Count enough graticule fields to yield 200 ends. Count a minimum of 20 graticule fields. Stop at 100 graticule fields, regardless of count.
7. Divide total end count by 2 to yield fiber count.

APPENDIX D. EQUIVALENT LIMITS OF DETECTION AND QUANTITATION

	fiber density on filter*		fiber concentration in air, f/cc	
	fibers per 100 fields	fibers/mm^2	400-L air sample	1000-L air sample
	200	255	0.25	0.10
	100	127	0.125	0.05
LOQ	80	102	0.10	0.04
	50	64	0.0625	0.025
	25	32	0.03	0.0125
	20	25	0.025	0.010
	10	12.7	0.0125	0.005
	8	10.2	0.010	0.004
LOD	5.5	7	0.00675	0.0027

* Assumes 385 mm^2 effective filter collection area, and field area = 0.00785 mm^2, for relatively "clean" (little particulate aside from fibers) filters.

SITE SPECIFIC HEALTH AND SAFETY PLAN

APPENDIX F

NIOSH ANALYTICAL METHOD 7402

ASBESTOS by TEM 7402

FORMULA: Various MW: Various CAS: Various RTECS: Various

METHOD: 7402 **EVALUATION: PARTIAL** **Issue 1: 15 May 1989**
Issue 2: 15 August 1994

OSHA : 0.1 asbestos fibers (>5 µm long)/cc; 1 f/cc/30 min excursion; carcinogen
MSHA: 2 asbestos fibers/cc
NIOSH: 0.1 f/cc (fibers > 5 µm long)/400 L; carcinogen
ACGIH: 0.2 crocidolite; 0.5 amosite; 2 chrysotile and other asbestos, fibers/cc; carcinogen

PROPERTIES: solid, fibrous, crystalline, anistropic

SYNONYMS [CAS#]: actinolite [77536-66-4] or ferroactinolite [15669-07-5]; amosite [12172-73-5]; anthophyllite [77536-67-5]; chrysotile [12001-29-5]; serpentine [18786-24-8]; crocidolite [12001-28-4]; tremolite [77536-68-6]; amphibole asbestos [1332-21-4].

SAMPLING

SAMPLER: FILTER (0.45- to 1.2-µm cellulose ester membrane, 25-mm diameter; conductive cassette)

FLOW RATE: 0.5 to 16 L/min

VOL-MIN*: 400 L @ 0.1 fiber/cc
-MAX*: (step 4, sampling)
*Adjust for 100 to 1300 fibers/mm^2

SHIPMENT: routine (pack to reduce shock)

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: 80 to 100 fibers counted

BIAS: not determined

OVERALL PRECISION ($\hat{S}_{rT}$): see EVALUATION OF METHOD

ACCURACY: not determined

MEASUREMENT

TECHNIQUE: MICROSCOPY, TRANSMISSION ELECTRON (TEM)

ANALYTE: asbestos fibers

SAMPLE PREPARATION: modified Jaffe wick

EQUIPMENT: transmission electron microscope; energy dispersive X-ray system (EDX) analyzer

CALIBRATION: qualitative electron diffraction; calibration of TEM magnification and EDX system

RANGE: 100 to 1300 fibers/mm^2 filter area [1]

ESTIMATED LOD: 1 confirmed asbestos fiber above 95% of expected mean blank value

PRECISION ($\hat{S}_r$): 0.28 when 65% of fibers are asbestos; 0.20 when adjusted fiber count is applied to PCM count [2].

APPLICABILITY: The quantitative working range is 0.04 to 0.5 fiber/cc for a 1000-L air sample. The LOD depends on sample volume and quantity of interfering dust, and is <0.01 fiber/cc for atmospheres free of interferences. This method is use d to determine asbestos fibers in the optically visible range and is intended to complement the results obtained by phase con trast microscopy (Method 7400).

INTERFERENCES: Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification. Some non-asbestos amphibole m inerals may give electron diffraction patterns similar to asbestos amphiboles.

OTHER METHODS: This method is designed for use with Method 7400 (phase contrast microscopy).

REAGENTS:

1. Acetone. (See SPECIAL PRECAUTIONS.)

EQUIPMENT:

1. Sampler: field monitor, 25-mm, three-piece cassette with ca. 50-mm electrically-conductive extension cowl, cellulose ester membrane filter, 0.45- to 1.2-µm pore size, and backup pad.
   NOTE 1: Analyze representative filters for fiber background before use. Discard the filter lot if mean count is >5 fibers/100 fields. These are defined as laboratory blanks.
   NOTE 2: Use an electrically-conductive extension cowl to reduce electrostatic effects on fiber sampling and during sample shipment. Ground the cowl when possible during sampling.
   NOTE 3: 0.8-µm pore size filters are recommended for personal sampling. 0.45-µm filters are recommended for sampling when performing TEM analysis on the samples because the particles deposit closer to the filter surface. However, the higher pressure drop through these filters normally preclude their use with personal sampling pumps.
2. Personal sampling pump, 0.5 to 16 L/min, with flexible connecting tubing.
3. Microscope, transmission electron, operated at ca. 100 kV, with electron diffraction and energy-dispersive X-ray capabilities, and having a fluorescent screen with inscribed or overlaid calibrated scale (Step 15).
   NOTE: The scale is most efficient if it consists of a series of lines inscribed on the screen or partial circles every 2 cm distant from the center.
4. Diffraction grating replica with known number of lines/mm.
5. Slides, glass, pre-cleaned, 25- x 75-mm.
6. Knife, surgical steel, curved-blade.
7. Tweezers.
8. Grids, 200-mesh TEM copper, (optional: carbon-coated).
9. Petri dishes, 15-mm depth. The top and bottom of the petri dish must fit snugly together. To assure a tight fit, grind the top and bottom pieces together with an abrasive such as carborundum to produce a ground-glass contact surface.
10. Foam, clean polyurethane, spongy, 12-mm thick.
11. Filters, Whatman No. 1 qualitative paper or equivalent, or lens paper.
12. Vacuum evaporator.
13. Cork borer, (about 8-mm).
14. Pen, waterproof, marking.
15. Reinforcement, page, gummed.
16. Asbestos standard bulk materials for reference; e.g. SRM #1866, available from the National Institute of Standards and Technology.
17. Carbon rods, sharpened to 1 mm x 8 mm.
18. Microscope, light, phase contrast (PCM), with Walton-Beckett graticule (see method 7400).
19. Grounding wire, 22-gauge, multi-strand.
20. Tape, shrink- or adhesive-.

SPECIAL PRECAUTIONS: Acetone is extremely flammable (flash point = 0 °F). Take precautions not to ignite it. Heating of acetone must be done in a fume hood using a flameless, spark-free heat source. Asbestos is a confirmed human carcinogen. Handle only in a well-ventilated fume hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. For personal sampling, fasten sampler to worker's lapel near worker's mouth. Remove the top cover from cowl extension ("open-face") and orient sampler face down. Wrap joint between extender and monitor body with tape to help hold the cassette together and provide a marking surface to identify the cassette. Where possible, especially at low %RH, attach sampler to electrical ground to reduce electrostatic effects during sampling.
3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Remove top covers from the field blank cassettes and store top covers and cassettes in a clean area (e.g., closed bag or box) during sampling. Replace top covers when sampling is completed.
4. Sample at 0.5 to 16 L/min [3]. Adjust sampling rate, Q (L/min), and time, t (min), to produce fiber density, E, of 100 to 1300 fibers/mm ^{2} [$3.85 \cdot 10^4$ to $5 \cdot 10^5$ fibers per 25-mm filter with effective collection area (A_c= 385 mm^2)] for optimum accuracy. Do not exceed ca. 0.5 mg total dust loading on the filter. These variables are related to the action level (one-half the current standard), L (fibers/cc), of the fibrous aerosol being sampled by:

$$t = \frac{A_c \cdot E}{Q \cdot L \cdot 10^3}, \text{ min.}$$

   NOTE: The purpose of adjusting sampling times is to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for 8 h (700 to 2800 L) is appropriate in atmospheres containing ca. 0.1 fiber/cc in the absence of significant amounts of non-asbestos dust. Dusty atmospheres require smaller sample volumes (≤400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres, where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3000 to 10000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust [3].
5. At the end of sampling, replace top cover and small end caps.
6. Ship samples upright with conductive cowl attached in a rigid container with packing material to prevent jostling or damage.
   NOTE: Do not use untreated polystyrene foam in the shipping container because electrostatic forces may cause fiber loss from sample filter.

SAMPLE PREPARATION:

7. Remove circular sections from any of three quadrants of each sample and blank filter using a cork borer [4]. The use of three grid preparations reduces the effect of local variations in dust deposit on the filter.
8. Affix the circular filter sections to a clean glass slide with a gummed page reinforcement. Label the slide with a waterproof marking pen.
   NOTE: Up to eight filter sections may be attached to the same slide.
9. Place the slide in a petri dish which contains several paper filters soaked with 2 to 3 mL acetone. Cover the dish. Wait 2 to 4 min for the sample filter(s) to fuse and clear.
   NOTE: The "hot block" clearing technique [5] of Method 7400 or the DMF clearing technique [6] may be used instead of steps 8 and 9.
10. Transfer the slide to a rotating stage inside the bell jar of a vacuum evaporator. Evaporate a 1- by 5-mm section of a graphite rod onto the cleared filter(s). Remove the slide to a clean, dry, covered petri dish [4].
11. Prepare a second petri dish as a Jaffe wick washer with the wicking substrate prepared from filter or lens paper placed on top of a 12-mm thick disk of clean, spongy polyurethane foam [7].

Cut a V-notch on the edge of the foam and filter paper. Use the V-notch as a reservoir for adding solvent.

NOTE: The wicking substrate should be thin enough to fit into the petri dish without touching the lid.

12. Place the TEM grid on the filter or lens paper. Label the grids by marking with a pencil on the filter paper or by putting registration marks on the petri dish halves and marking with a waterproof marker on the dish lid. In a fume hood, fill the dish with acetone until the wicking substrate is saturated.

    NOTE: The level of acetone should be just high enough to saturate the filter paper without creating puddles.

13. Remove about a quarter section of the carbon-coated filter from the glass slide using a surgical knife and tweezers. Carefully place the excised filter, carbon side down, on the appropriately-labeled grid in the acetone-saturated petri dish. When all filter sections have been transferred, slowly add more solvent to the wedge-shaped trough to raise the acetone level as high as possible without disturbing the sample preparations. Cover the petri dish. Elevate one side of the petri dish by placing a slide under it (allowing drops of condensed acetone to form near the edge rather than in the center where they would drip onto the grid preparation).

CALIBRATION AND QUALITY CONTROL:

14. Determine the TEM magnification on the fluorescent screen:
    a. Define a field of view on the fluorescent screen either by markings or physical boundaries.
       NOTE: The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric) [7].
    b. Insert a diffraction grating replica into the specimen holder and place into the microscope. Orient the replica so that the grating lines fall perpendicular to the scale on the TEM fluorescent screen. Ensure that goniometer stage tilt is zero.
    c. Adjust microscope magnification to 10,000X. Measure the distance (mm) between the same relative positions (e.g., between left edges) of two widely-separated lines on the grating replica. Count the number of spaces between the lines.
       NOTE: On most microscopes the magnification is substantially constant only within the central 8- to 10-cm diameter region of the fluorescent screen.
    d. Calculate the true magnification (M) on the fluorescent screen:

$$m = \frac{X \cdot G}{Y}$$

       where: X = total distance (mm) between the two grating lines;
       G = calibration constant of the grating replica (lines/mm);
       Y = number of grating replica spaces counted
    e. After calibration, note the apparent sizes of 0.25 and 5.0 µm on the fluorescent screen. (These dimensions are the boundary limits for counting asbestos fibers by phase contrast microscopy.)
15. Measure 20 grid openings at random on a 200-mesh copper grid by placing a grid on a glass slide and examining it under the PCM. Use the Walton-Beckett graticule to measure the grid opening dimensions. Calculate an average graticule field dimension from the data and use this number to calculate the graticule field area for an average grid opening.

    NOTE: A grid opening is considered as one graticule field.

16. Obtain reference selected area electron diffraction (SAED) or microdiffraction patterns from standard asbestos materials prepared for TEM analysis.

    NOTE: This is a visual reference technique. No quantitative SAED analysis is required [7]. Microdiffraction may produce clearer patterns on very small fibers or fibers partially obscured by other material.

    a. Set the specimen holder at zero tilt.

b. Center a fiber, focus, and center the smallest field-limiting aperture on the fiber. Obtain a diffraction pattern. Photograph each distinctive pattern and keep the photo for comparison to unknowns.

NOTE: Not all fibers will present diffraction patterns. The objective lens current may need adjustment to give optimum pattern visibility. There are many more amphiboles which give diffraction patterns similar to the analytes named on p. 7402-1. Some, but not all, of these can be eliminated by chemical separations. Also, some non-amphiboles (e.g., pyroxenes, some talc fibers) may interfere.

17. Acquire energy-dispersive X-ray (EDX) spectra on approximately 5 fibers having diameters between 0.25 and 0.5 µm of each asbestos variety obtained from standard reference materials [7].

NOTE: The sample may require tilting to obtain adequate signal. Use same tilt angle for all spectra.

a. Prepare TEM grids of all asbestos varieties.
b. Use acquisition times (at least 100 sec) sufficient to show a silicon peak at least 75% of the monitor screen height at a vertical scale of ≥500 counts per channel.
c. Estimate the elemental peak heights visually as follows:
   (1) Normalize all peaks to silicon (assigned an arbitrary value of 10).
   (2) Visually interpret all other peaks present and assign values relative to the silicon peak.
   (3) Determine an elemental profile for the fiber using the elements Na, Mg, Si, Ca, and Fe. Example: 0-4-10-3-<1 [7].

   NOTE: In fibers other than asbestos, determination of Al, K, Ti, S, P, and F may also be required for fiber characterization.

   (4) Determine a typical range of profiles for each asbestos variety and record the profiles for comparison to unknowns.

MEASUREMENT:

18. Perform a diffraction pattern inspection on all sample fibers counted under the TEM, using the procedures given in step 17. Assign the diffraction pattern to one of the following structures:
   a. chrysotile;
   b. amphibole;
   c. ambiguous;
   d. none.

   NOTE: There are some crystalline substances which exhibit diffraction patterns similar to those of asbestos fibers. Many of these, (brucite, halloysite, etc.) can be eliminated from consideration by chemistry. There are, however, several minerals (e.g., pyroxenes, massive amphiboles, and talc fibers) which are chemically similar to asbestos and can be considered interferences. The presence of these substances may warrant the use of more powerful diffraction pattern analysis before positive identification can be made. If interferences are suspected, morphology can play an important role in making positive identification.

19. Obtain EDX spectra in either the TEM or STEM modes from fibers on field samples using the procedure of step 18. Using the diffraction pattern and EDX spectrum, classify the fiber:
   a. For a chrysotile structure, obtain EDX spectra on the first five fibers and one out of ten thereafter. Label the range profiles from 0-5-10-0-0 to 0-10-10-0-0 as "chrysotile."
   b. For an amphibole structure, obtain EDX spectra on the first 10 fibers and one out of ten thereafter. Label profiles ca. 0-2-10-0-7 as "possible amosite"; profiles ca. 1-1-10-0-6 as "possible crocidolite"; profiles ca. 0-4-10-3-<1 as "possible tremolite"; and profiles ca. 0-3-10-0-1 as "possible anthophyllite."

      NOTE: The range of profiles for the amphiboles will vary up to ± 1 unit for each of the elements present according to the relative detector efficiency of the spectrometer.

   c. For an ambiguous structure, obtain EDX spectra on all fibers. Label profiles similar to the chrysotile profile as "possible chrysotile." Label profiles similar to the various amphiboles as "possible amphiboles." Label all others as "unknown" or "non-asbestos."

20. Counting and Sizing:
    a. Insert the sample grid into the specimen grid holder and scan the grid at zero tilt at low magnification (ca. 300 to 500X). Ensure that the carbon film is intact and unbroken over ca. 75% of the grid openings.
    b. In order to determine how the grids should be sampled, estimate the number of fibers per grid opening during a low-magnification scan (500 to 1000X). This will allow the analyst to cover most of the area of the grids during the fiber count and analysis. Use the following rules when picking grid openings to count [7,8]:
        (1) Light loading (<5 fibers per grid opening): count total of 40 grid openings.
        (2) Moderate loading (5 to 25 fibers per grid opening): count minimum of 40 grid openings or 100 fibers.
        (3) Heavy loading (>25 fibers per opening): count a minimum of 100 fibers and at least 6 grid openings.

        Note that these grid openings should be selected approximately equally among the three grid preparations and as randomly as possible from each grid.
    c. Count only grid openings that have the carbon film intact. At 500 to 1000X magnification, begin counting at one end of the grid and systematically traverse the grid by rows, reversing direction at row ends. Select the number of fields per traverse based on the loading indicated in the initial scan. Count at least 2 field blanks per sample set to document possible contamination of the samples. Count fibers using the following rules:
        (1) Count all particles with diameter greater than 0.25 µm that meet the definition of a fiber (aspect ratio ≥3:1, longer than 5 µm). Use the guideline of counting all fibers that would have been counted under phase contrast light microscopy (Method 7400). Use higher magnification (10000X) to determine fiber dimensions and countability under the acceptance criteria. Analyze a minimum of 10% of the fibers, and at least 3 asbestos fibers, by EDX and SAED to confirm the presence of asbestos. Fibers of similar morphology under high magnification can be identified as asbestos without SAED. Particles which are of questionable morphology should be analyzed by SAED and EDX to aid in identification.
        (2) Count fibers which are partially obscured by the grid as half fibers.
            NOTE: If a fiber is partially obscured by the grid bar at the edge of the field of view, count it as a half fiber only if more than 2.5 µm of fiber is visible.
        (3) Size each fiber as it is counted and record the diameter and length:
            (a) Move the fiber to the center of the screen. Read the length of the fiber directly from the scale on the screen.
                NOTE 1: Data can be recorded directly off the screen in µm and later converted to µm by computer.
                NOTE 2: For fibers which extend beyond the field of view, the fiber must be moved and superimposed upon the scale until its entire length has been measured.
            (b) When a fiber has been sized, return to the lower magnification and continue the traverse of the grid area to the next fiber.
    d. Record the following fiber counts:
        (1) f_s, f_b = number of asbestos fibers in the grid openings analyzed on the sample filter and corresponding field blank, respectively.
        (2) F_s, F_b = number of fibers, regardless of identification, in the grid openings analyzed on the sample filter and corresponding field blank, respectively.

CALCULATIONS:

21. Calculate and report the fraction of optically visible asbestos fibers on the filter, $(f_s - f_b)/(F_s - F_b)$. Apply this fraction to fiber counts obtained by PCM on the same filter or on other filters for which the TEM sample is representative. The final result is an asbestos fiber count. The type of asbestos present should also be reported.
22. As an integral part of the report, give the model and manufacturer of the TEM as well as the model and manufacturer of the EDX system.

EVALUATION OF METHOD:

The TEM method, using the direct count of asbestos fibers, has been shown to have a precision of 0.275 (s_r) in an evaluation of mixed amosite and wollastonite fibers. The estimate of the asbestos fraction, however, had a precision of 0.11 (s_r). When this fraction was applied to the PCM count, the overall precision of the combined analysis was 0.20 [2].

REFERENCES:

[1] Walton, W. H. "The Nature, Hazards, and Assessment of Occupational Exposure to Airborne Asbestos Dust: A Review," Ann. Occup. Hyg., 25, 115-247 (1982).
[2] Taylor, D. G., P. A. Baron, S. A. Shulman and J. W. Carter. "Identification and Counting of Asbestos Fibers," Am. Ind. Hyg. Assoc. J. 45(2), 84-88 (1984).
[3] Johnston, A. M., A. D. Jones, and J. H. Vincent. "The Influence of External Aerodynamic Factors on the Measurement of the Airborne Concentration of Asbestos Fibers by the Membrane Filter Method," Ann. Occup. Hyg., 25, 309-316 (1982).
[4] Zumwalde, R. D. and J. M. Dement. Review and Evaluation of Analytical Methods for Environmental Studies of Fibrous Particulate Exposures, NIOSH Technical Information Bulletin #77-204 (1977).
[5] Baron, P. A. and G. C. Pickford. "An Asbestos Sample Filter Clearing Procedure," Appl. Ind. Hyg., 1:169-171,199 (1986).
[6] LeGuen, J. M. and S. Galvin "Clearing and Mounting Techniques for the Evaluation of Asbestos Fibers by the Membrane Filter Method" Ann. Occup. Hyg. 24, 273-280 (1981).
[7] Yamate, G., S. A. Agarwal, and R. D. Gibbons. "Methodology for the Measurement of Airborne Asbestos by Electron Microscopy," EPA Contract No. 68-02-3266 (in press).
[8] Steel, E. B. and J. A. Small. "Accuracy of Transmission Electron Microcopy for the Analysis of Asbestos in Ambient Environments," Anal. Chem., 57, 209-213 (1985).

METHOD REVISED BY:

Paul A. Baron, Ph.D.; NIOSH/DPSE.

ATTACHMENT

MATERIAL SAFETY DATA SHEETS

(None Anticipated)

TETRA TECH EM INC.

HEALTH AND SAFETY PLAN AMENDMENT

Site Name: Troy Asbestos Property Evaluation (TAPE)

Amendment Date: July 7, 2009

Purpose or Reason for Amendment: Ambient Air Monitoring is being added to the tasks at the site. This will require construction of up to seven sampling stations. The duration of the air sampling will be at least one year. Tetra Tech personnel will assemble and provide basic maintenance of the sampling stations, as well as collect samples from the stations. Ambient air in the area is not expected to contain dangerous levels of asbestos and the risk of exposure during this task is low. It will provide no excess risk to the community or Tetra Tech personnel because all are already exposed to the ambient air.

Required Changes in SOP: Tetra Tech personnel will be required to wear level C PPE during assemblage of the stations. Level C with half face respirators with p100 (HEPA) cartridges and personal air monitors will be required for the first 8 hours of sampling to extrapolate a 40 hour TWA. If personal samples show acceptable exposures, PPE will de downgraded to level D. 8 hour personal samples will then be collected once per month to demonstrate appropriate exposures. Tetra Tech personnel will assemble and maintain the sampling stations. Any and all electrical work necessary for the stations will be performed by a journeyman electrician.

Action Level Changes: If personal samples or ambient air samples show asbestos at concentrations exceeding the PEL or REL, level C PPE tyvek suits with booties and half face respirators with p100 (HEPA) cartridges will be required.

AMENDMENT APPROVAL

HSD or Designee			
Nam	e	Signature	Date
Site Safety Coordinator			
Nam	e	Signature	Date

Date presented during daily site safety meeting: _____

APPENDIX B

TECHNICAL ANALYSIS FOR NUMBER OF SAMPLES

Approach for Determining Minimum Sample-Size Requirements

The approach for determining the minimum number of samples needed to provide a reliable estimate of the exposure point concentration (EPC) for airborne levels of Libby amphibole (LA) followed EPA (2006). EPA (2006) describes an approach to establish a precision-based performance criterion for calculating an upper confidence level (UCL) for the unknown mean concentration of LA. The one-sided 95 percent UCL of the mean is the concentration term in the Risk Assessment Guidance for Superfund (RAGS) that is used to estimate the EPC (EPA 1992, 2009a, 2009b).

EPA (2006) describes a mixed Poisson-lognormal model, where the ratio of the UCL to the mean (UCL/Mean) is used as a measure of statistical uncertainty. Calculation of the UCL/Mean was used in EPA (2006) to quantify tolerable limits for Type II (false positive) decision errors in the Data Quality Objectives (DQO) process. In this context, a false positive decision error was associated with overestimation of the true mean via calculation of an inflated estimate for the UCL. This outcome is likely if the noise or variance of a sample is high, so an upper bound or performance target for the precision for calculating the UCL was established. Acceptable limits for the precision were based on calculation of a UCL that did not exceed the sample mean by a factor greater than 3 (i.e., UCL/Mean $\leq$ 3).

The UCL/Mean is calculated using the following equation [attributed to Hass et al. (1999) in EPA (2006)]:

$$\frac{UCL}{Mean} = \exp\left\lfloor \frac{sH}{n-1} \right\rfloor, \text{ where}$$

s= standard deviation of the natural logs of the data
H= constant from tables published in Land (1975) and reproduced in some statistical texts (see Gilbert, 1987)
n= sample size

This formula is derived through algebraic manipulation of Land's model for calculating the UCL of a lognormal distribution (see Gilbert 1987; EPA 2009a, 2009b for discussion). Values for UCL/Mean are calculated for a range of sample sizes, assuming one or more fixed values for the expected variability (defined by s). A sensitivity analysis is conducted, wherein performance curves are generated to show the relationship between UCL/Mean and increasing sampling sizes for each fixed level of s. Minimum sample sizes for achieving the precision target are determined for each curve (assumed variability, based on s) by finding the sample sizes that will result in values for UCL/Mean $\leq$ 3 (i.e., finding the intersection of UCL/Mean and n for each curve).

This approach assumes the data follow a lognormal distribution. This assumption was tested in the present study by determining the underlying distribution of an existing data set (n= 622) through application of formal goodness-of-fit (GOF) tests and examination of graphical exhibits (quantile probability plots or Q-Q plots, outlier box plots, frequency

histograms). The Shapiro-Wilk W test was used to determine whether the logarithms of the data follow a normal distribution (equivalent to testing that the data in the original scale follow a lognormal distribution).

It should be noted that GOF tests can be confounded by the presence of censored (results that are nondetect or below the detection limit) data. In the present study, only 83 or 13 percent of the 622 results were detected. The default in EPA's ProUCL software package is to perform GOF tests on the detected data only. This effectively treats censored results as a nuisance variable, and in the present case would remove the confounding effect of having a large number of results reported at the same value (censoring limit). When a large number of results are fixed at the same value for one or more detection limits, this produces a staircase pattern when the data are plotted, and can adversely affect the GOF tests, leading to incorrect specification of the underlying distribution. However, ignoring the censored results can also produce misleading results, especially in cases where the remaining detected data are no longer representative of the underlying distribution (e.g., excluding nondetects may remove a significant portion of the left-hand tail of the distribution, thus altering the overall shape of the distribution).

Several different approaches were used to test the underlying distribution as well as control for the confounding effect of the large proportion of censored results. First, GOF tests were conducted and plots prepared for the detected data only, and for the detected plus censored data, where one-half the detection limit was substituted for the nondetect results. The results are shown in the top two panels in Figure 1. In both cases the quantile probability plots (plots of the observed quantiles of the data against the expected quantiles of a theoretical normal distribution) show a non-linear fit, indicating the data do not follow a normal distribution (or lognormal distribution in the original scale). This is also reflected by the low p value ($p < 0.05$) for the Shapiro-Wilk W test, indicating rejection of the null hypothesis that the data follow a normal distribution. Neither of these findings is surprising given the potential confounding effects that can be introduced by only considering the detected data, or using substituted values (tied at the same value) for nondetect data, for large data sets with only a small number of detected results.

In order to assess the distribution of the full data set, but also account for the confounding influence of a large proportion of nondetect results tied at multiple detection limits, a third approach was used. This approach employed Helsel's robust regression on order statistics (ROS) method (see Helsel, 2005 for full details; note that several ROS methods are incorporated in EPA's ProUCL software). Robust ROS was used to compute a linear regression for the detected data (in natural log units) versus their standard normal scores (quantiles). The regression line was passed through the censored data, and values for individual censored results were predicted based on their normal scores. The predicted or "fill in" values for the censored results were then combined with the detected data and used to calculate summary statistics and perform GOF tests. Retransformation of individual predicted censored values instead of the fitted parameters of a regression model, avoids the problem of transformation bias when summary statistics are calculated. In this case, the detected and fill-in values were combined, transformed back to natural logarithms, and GOF testing was conducted.

Plots of the combined detected and fill-in values calculated using robust ROS are shown in the bottom panel of Figure 1. It can be seen in these plots, and confirmed by results of the Shapiro-Wilk W tests (p= 0.15, indicating failure to reject the null hypothesis), that the data follow a normal distribution (lognormal distribution in the original scale). This is not surprising, given that the procedure used to extrapolate the fill-in values for the censored data assumed the nondetect fraction of the data followed a lognormal distribution.

The purpose of the GOF testing and the exercise to try and fit the data to a lognormal distribution, was to generate a plausible range of values to use for s (standard deviation of the logs of the data) in the sensitivity analysis. Calculation of s for the logarithms of the detected data only, detected plus censored data (simple substitution used to replace censored results), and the detected plus censored data (censored results replaced by fill-in values from robust ROS) yielded values of 0.57, 0.43, and 1.13. It was decided to use values of 0.50, 0.75, and 1.25 as low, medium, and high estimates for s.

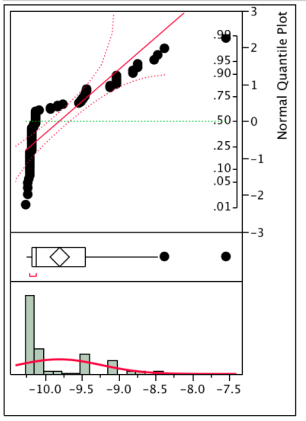
Figure 2 presents results of the sensitivity analysis, which shows the effect of sample size on the precision for estimating the unknown mean, assuming a plausible range for the expected variability in the data. From the plots in Figure 2, it can be seen that even for the highest estimate for the expected variability (although this is probably the most technically defensible estimate), only a very small number of samples is needed to achieve the precision target of UCL/Mean <_ 3. In fact, as few as 25 samples would result in a UCL/Mean of approximately 2.

This finding, however, is potentially misleading, as it doesn't adequately account for the fact that the data used in this exercise are characterized by a very low frequency of detection. That is, if the existing data are representative of the results that would be obtained from future samples, then it is expected that future data sets would also be characterized by a relatively low detection frequency. Robust estimates of the mean and standard deviation used to calculate the UCL (and EPC) require a minimum number of detected results. The minimum number or proportion of detected results depends on a number of factors, including the relative skewness of the distribution, so cannot be defined beforehand. However, ProUCL and EPA guidance recommend that every effort should be made to obtain as large a sample (and as many detected results) as practical.

The number (or proportion) of detected results in future samples can be estimated, assuming that future samples are derived from the same population as the existing data. This is because the detection frequency is a binomial proportion (i.e., each datum is described by one of two conditions, detected or nondetect), and properties of the binomial distribution can be used to calculate two-sided confidence limits for the expected number (or proportion) of detected results in samples of any fixed size. For the existing data (detection frequency= 83/622), the two-sided 95 percent confidence interval for the proportion of detected results is 0.11, 0.16. Therefore, for a future sample of size n= 100, it is expected that between 11 to 16 of these results will be detected. This number is unlikely to be sufficient to support a robust estimate of the UCL for a lognormal

Figure 1. Results of Goodness-of-Fit Tests

Detected Data Only (n= 83)



Normal(-9.8059,0.5765)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	-9.80594	-9.931822	-9.680058
Dispersion	σ	0.5764992	0.5001696	0.6805378

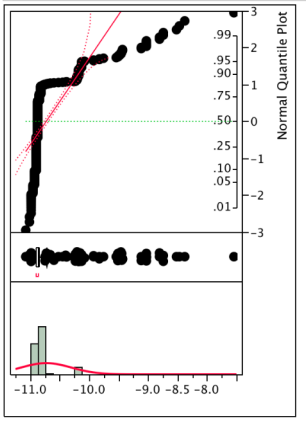
Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.735216	<.0001*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

All Data (n=622), One-Half DL Substituted For Censored Results



Normal(-10.727,0.42506)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	-10.72743	-10.7609	-10.69396
Dispersion	σ	0.4250556	0.4026753	0.4500899

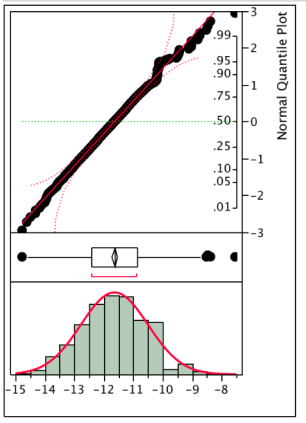
Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.482780	0.0000*

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

All Data (n= 622), Helsel's Robust ROS Method Used to Calculate Fill-In Values for Censored Data



Normal(-11.636,1.13814)

Fitted Normal

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	μ	-11.63614	-11.72576	-11.54652
Dispersion	σ	1.1381412	1.078215	1.2051737

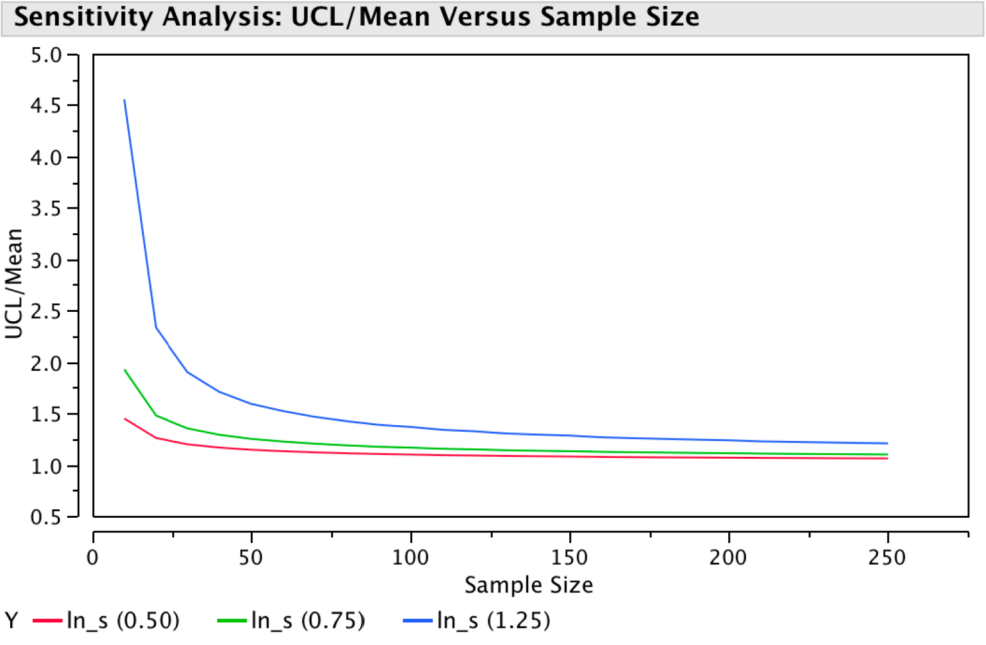
Goodness-of-Fit Test

Shapiro-Wilk W Test

W	Prob<W
0.996275	0.1524

Note: Ho = The data is from the Normal distribution. Small p-values reject Ho.

Figure 2. Sensitivity Analysis for Determining Minimum Sample-Size Requirements



distribution. In order to assure a minimum of 20-25 detected results, a target sample-size in the range of 150 to 200 is recommended.

References

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. John Wiley & Sons, Inc., New York, NY.

Haas, C.N., Rose, J.B., and C.P. Gerba. 1999. *Quantitative Microbial Risk Assessment*. John Wiley and Sons, New York, NY.

Helsel, D.R. 2005. *Nondetects and Data Analysis*. Statistics for Censored Environmental Data. John Wiley and Sons, Inc. Hoboken, NJ. 250 p.

Land, C.E. 1975. "Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance." In *Selected Tables in Mathematic Statistics, Vol. III*. American Mathematical Society, Providence, R.I.

U.S. Environmental Protection Agency (EPA). 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. Intermittent Bulletin, Volume 1, Number 1. Publication 9285.7-081.

EPA. 2006. "Final – Revision 1, Sampling and Analysis Plan for Outdoor Ambient Air Monitoring at the Libby Asbestos Site, Operable Unit 4, Libby, Montana." Region 8, Denver, Co. December.

EPA. 2009a. "ProUCL Version 4.00.04 Technical Guide (Draft)." Prepared by Singh, A. and A.K. Singh. EPA/600/R-07/041. February.

EPA. 2009b. "ProUCL Version 4.00.02 User Guide (Draft)." Singh, A., Maichle, R., Singh, A.K., Lee, S.E., and N. Armbya. Office of Research and Development, National Exposure Research Laboratory, EPA/600/R-07/038. February.

APPENDIX C

ACCESS AGREEMENT LETTER AND AGREEMENTS FOR LANDOWNERS

Date

Name
Add
C/S/Z

Re: Outdoor Ambient Air Sampling Station Number: _____

The Montana Department of Environmental Quality (DEQ) appreciates your willingness to participate in the Outdoor Ambient Air Sampling Program. The goal of the sampling program is to collect data on the presence of Libby amphibole asbestos in outdoor ambient air near and within the City of Troy. DEQ has contracted with Tetra Tech EMI to perform the field work related to this sampling program.

For quick reference, here are some facts about the program and your participation:

1) The initial sampling program will continue for at least one calendar year;
2) The sampling unit and all necessary equipment will be provided and maintained by DEQ;
3) The sampling unit will run continuously for 5 days and then be shut off for 5 days, continuing with this sampling cycle for one full year;
4) Tetra Tech will inspect the sampling unit each day for the first two sampling cycles and then once or twice per sampling cycle from then on when in operation;
5) If you execute the attached Consent for Entry and Access to Property, you will not need to be present when the unit is inspected or when samples are collected
6) DEQ and/or Tetra Tech will work with you to find an appropriate location on your property for the sampling unit;
7) The sampling units will run from battery and thus not impact your electrical service;
8) DEQ will release a report of findings quarterly for the first year of sampling;
9) You must agree to not tamper with the sampling unit, and to promptly report any damage or power outages to DEQ by calling _____; and
10) You must agree to provide reasonable notice to DEQ before disturbing any soil near the sampling unit.

Again, we want to thank you for your participation in this very important program. If you have any questions or concerns, please do not hesitate to contact me at (406) 841-5040, toll free in Montana at 1-800-246-8198 or electronically at clecours@mt.gov.

Sincerely,

Catherine LeCours
DEQ Project Manager

Montana Department of Environmental Quality
Remediation Division/Federal Superfund Section

DEQ Troy Information Center
303 N. Third St., PO Box 1170
Troy MT 59935
Local in Troy 406.295.9238

1100 North Last Chance Gulch
PO Box 200901
Helena MT 59620-0901
406.841.5040 or 1.800.246.8198

CONSENT FOR ENTRY AND ACCESS TO PROPERTY
DEQ Ambient Air Station Tracking Number _____

Name:		**Home phone:**	
Mailing Address:		**Work phone:**	
City/St/Zip:		**Cell phone:**	

Legal description/Address of property for which consent for entry and access is being granted:

Legal Property Description _____ Property Address _____

Relationship to property: _____
(i.e., owner, owner's representative, tenant, etc.)

I, the undersigned, am the owner, their representative, or otherwise control the real property at the location described above. The State of Montana's Department of Environmental Quality (DEQ) and the United States Environmental Protection Agency (EPA) have requested entry and access to my property pursuant to its response and enforcement responsibilities under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended (Superfund), 42 U.S.C. 9601 et seq.

I hereby authorize DEQ and EPA, and the authorized representatives of either or both agencies (including: officers, employees, contractors, and other agents) to enter and have continued access at all reasonable times to my property at the above-written address for the following purposes:

1. Visual inspection of the property, including the exterior of any home or any other structures on the property;

2. Construction and maintenance of a temporary structure to house air sampling equipment and installation of the air sampling equipment which includes a pump, tubing, internal battery power supply, and cassette filter mounted on a tripod;

3. Collection of air samples as may be determined to be necessary by DEQ; and

4. Maintenance of the air sampling equipment.

This written permission is given by me voluntarily with knowledge of my right to refuse and without threats or promises of any kind. I certify that this Consent for Entry and Access is entered into voluntarily and constitutes an unconditional consent and grant of permission for access to the property by employees and authorized representatives of DEQ and DEQ contractors at reasonable times.

I agree to provide reasonable notice to DEQ by calling _____ prior to initiating any activities near the air sampling equipment which have the potential to disturb soil. Except when soil disturbing activities are necessary to avoid or correct an unexpected emergency condition, 2 days notice prior to initiating soil disturbing activity shall be considered reasonable. I will promptly notify DEQ of any soil disturbing activities conducted in response to an unexpected emergency or threat of such an emergency.

In addition, I agree that I will not disturb the monitoring equipment and that I will notify DEQ immediately of any disturbance to the equipment of which I am aware.

My signature evidences my consent for entry and access to my above-described property and my acceptance of the above-stated terms.

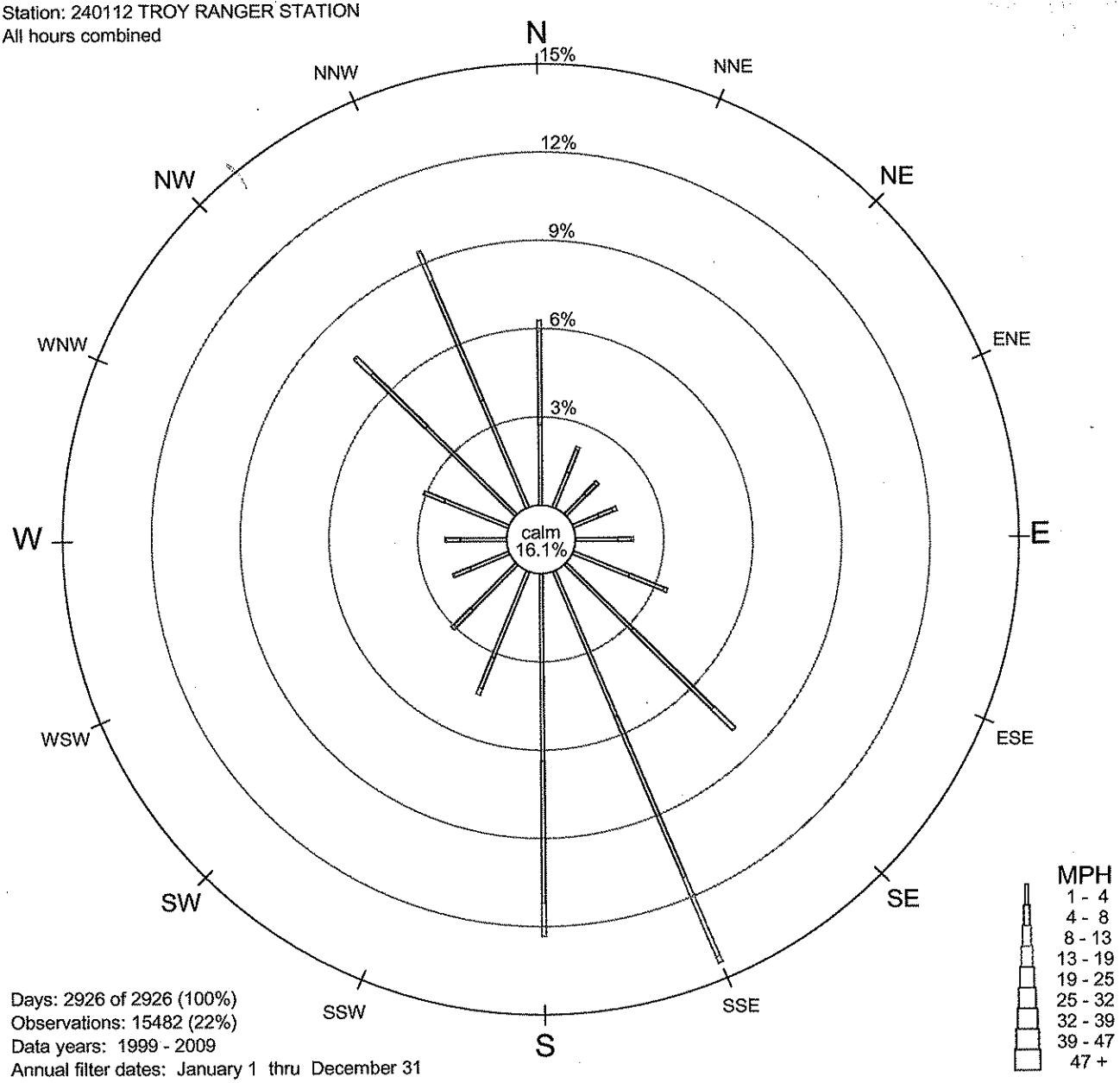
Print Name:_____

Signature:_____Date:_____

APPENDIX D

TROY RANGER STATION WIND ROSE AND DATA

Station: 240112 TROY RANGER STATION
All hours combined



Days: 2926 of 2926 (100%)
Observations: 15482 (22%)
Data years: 1999 - 2009
Annual filter dates: January 1 thru December 31

Total of all hourly periods

MPH Range	Direction N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
1-4	2.7	1.3	1.0	0.9	1.4	2.0	3.2	5.3	6.4	3.2	2.2	1.4	1.6	2.3	4.3	4.0	43.2
4-8	3.2	0.8	0.5	0.5	0.5	1.3	3.8	5.9	4.8	1.1	0.8	0.6	0.5	0.7	2.6	4.4	32.1
8-13	0.4	0.1	0.1	0.1	0.1	0.1	1.0	2.9	1.1	0.2	0.1	0.1	0.0	0.1	0.7	1.0	8.3
13-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4
19-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32-39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39-47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47 +	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total (%)	6.3	2.2	1.6	1.6	2.0	3.4	8.0	14.4	12.3	4.5	3.1	2.1	2.1	3.1	7.6	9.5	83.9
Calm (<1)																	16.1
Ave Speed (MPH)	3.3	3.0	2.9	3.4	2.8	3.1	4.3	4.8	3.4	2.2	1.9	1.6	1.4	1.6	3.1	4.1	3.3

15482 total observations used out of a possible 70224 (22%)
2926 days (2926 w/ complete wind dirs - 100%)

APPENDIX E

EPA SOP 2015
ASBESTOS SAMPLING

ASBESTOS SAMPLING

SOP#: 2015
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

Asbestos has been used in many commercial products including building materials such as flooring tiles and sheet goods, paints and coatings, insulation, and roofing asphalts. These products and others may be found at hazardous waste sites hanging on overhead pipes, contained in drums, abandoned in piles, or as part of a structure. Asbestos tailing piles from mining operations can also be a source of ambient asbestos fibers. Asbestos is a known carcinogen and requires air sampling to assess airborne exposure to human health. This Standard Operating Procedure (SOP) provides procedures for asbestos air sampling by drawing a known volume of air through a mixed cellulose ester (MCE) filter. The filter is then sent to a laboratory for analysis. The U.S. Environmental Protection Agency/Environmental Response Team (U.S. EPA/ERT) uses one of four analytical methods for determining asbestos in air. These include: U.S. EPA's Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air for Transmission Electron Microscopy (TEM)[1]; U.S. EPA's Modified Yamate Method for TEM[2]; National Institute for Occupational Safety and Health (NIOSH) Method 7402 (direct method only) for TEM; and NIOSH Method 7400 for Phase Contrast Microscopy (PCM) [3]. Each method has specific sampling and analytical requirements (i.e., sample volume and flow rate) for determining asbestos in air.

The U.S. EPA/ERT typically follows procedures outlined in the TEM methods for determining mineralogical types of asbestos in air and for distinguishing asbestos from non-asbestos minerals. The Phase Contrast Microscopy (PCM) method is used by U.S. EPA/ERT as a screening tool since it is less costly than TEM. PCM cannot distinguish asbestos from non-asbestos fibers, therefore the TEM method may be necessary to confirm analytical results. For example, if an action level for the presence of fibers has been set and PCM analysis indicates that the action level has been exceeded, then TEM analysis can be used to quantify and identify asbestos structures through examination of their morphology crystal structures (through electron diffraction), and elemental composition (through energy dispersive X-ray analysis). In this instance samples should be collected for both analyses in side by side sampling trains (some laboratories are able to perform PCM and TEM analysis from the same filter). The Superfund method is designed specifically to provide results suitable for supporting risk assessments at Superfund sites, it is applicable to a wide range of ambient air situations at hazardous waste sites. U.S. EPA's Modified Yamate Method for TEM is also used for ambient air sampling due to high volume requirements. The PCM and TEM NIOSH analytical methods require lower sample volumes and are typically used indoors; however, ERT will increase the volume requirement for outdoor application.

Other Regulations pertaining to asbestos have been promulgated by U.S. EPA and OSHA. U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations (40 CFR Part 61, Subparts A and M). U.S. EPA's 40 CFR 763 (July 1, 1987) [4] and its addendum 40 CFR 763 (October 30, 1987)[4] provide comprehensive rules for the asbestos abatement industry. State and local regulations on these issues vary and may be more stringent than federal requirements. The OSHA regulations in 29 CFR 1910.1001 and 29 CFR 1926.58 specify work practices and safety equipment such as respiratory protection and protective clothing when handling asbestos. The OSHA standard for an 8-hour, time-weighted average (TWA) is 0.2 fibers/cubic centimeters of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length >5 µm[5,6]. An action level of 0.1 fiber/cc (one-half the OSHA standard) is the level U.S. EPA has established in which employers must initiate such activities as air monitoring, employee training, and

medical surveillance [5,6].

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, the site should be characterized by identifying on-site as well as off-site sources of airborne asbestos. The array of sampling locations and the schedule for sample collection, is critical to the success of an investigation. Generally, sampling strategies to characterize a single point source are fairly straightforward, while multiple point sources and area sources increase the complexity of the sampling strategy. It is not within the scope of this SOP to provide a generic asbestos air sampling plan. Experience, objectives, and site characteristics will dictate the sampling strategy.

During a site investigation, sampling stations should be arranged to distinguish spatial trends in airborne asbestos concentrations. Sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case) or area of concern (downwind), crosswind, as well as background (upwind) contributions be quantified. See Table 1 (Appendix A) for U.S. EPA/ERT recommended sampling set up for ambient air. Indoor asbestos sampling requires a different type of strategy which is identified in Table 2 (Appendix A). It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

Much information can be derived from each analytical method previously mentioned. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. The site sampling objectives should be carefully identified so as to select the most appropriate analytical method. Additionally, some preparation (i.e., lot blanks results) prior to site sampling may be required, these requirements are specified in the analytical methods.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container and Storage Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers. The original cassette box is used to hold the samples.

2. Wrap the cassette individually in a plastic sample bag. Each bag should be marked indicating sample identification number, total volume, and date.

3. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand carry to lab.

4. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates exceeding 16 liters/minute (L/min) which could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

4.1 U.S. EPA's Superfund Method

4.1.1 Direct-transfer TEM Specimen Preparation Methods

Direct-Transfer TEM specimen preparation methods have the following significant interferences:

- The achievable detection limit is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high a particulate loading occurs on the filter, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. If too high a fiber loading occurs on the filter, even if satisfactory TEM specimens can be prepared, accurate fiber counting will not be possible.

4.1.2 Indirect TEM Specimen Preparation Methods

Indirect TEM specimen preparation methods have the following interferences:

- The size distribution of asbestos structures is modified.

- There is increased opportunity for fiber loss or introduction of extraneous contamination.

- When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 U.S. EPA's Modified Yamate Method for TEM

High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

5.0 EQUIPMENT/MATERIALS

5.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow-rate and pumping time sufficient to achieve the desired volume of air sampled.

The lower flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters/minute (cc/min) to 4 L/min. These pumps are usually battery powered. High flow pumps are utilized when flow rates between 2 L/min to 20 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. High flow pumps usually run on AC power and can be plugged into a nearby outlet. If an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several

electrical extension cords may be required if sampling locations are remote.

The recommended volume for the Superfund method (Phase I) requires approximately 20 hours to collect. Such pumps typically draw 6 amps at full power so that 2 lead/acid batteries should provide sufficient power to collect a full sample. The use of line voltage, where available, eliminates the difficulties associated with transporting stored electrical energy.

A stand should be used to hold the filter cassette at the desired height for sampling and the filter cassette shall be isolated from the vibrations of the pump.

5.2 Filter Cassette

The cassettes are purchased with the required filters in position, or can be assembled in a laminar flow hood or clean area. When the filters are in position, a shrink cellulose band or adhesive tape should be applied to cassette joints to prevent air leakage.

5.2.1 TEM Cassette Requirements

Commercially available field monitors, comprising 25 mm diameter three-piece cassettes, with conductive extension cowls shall be used for sample collection. The cassette must be new and not previously used. The cassette shall be loaded with an MCE filter of pore size 0.45 µm, and supplied from a lot number which has been qualified as low background for asbestos determination. The cowls should be constructed of electrically conducting material to minimize electrostatic effects. The filter shall be backed by a 5 µm pore size MCE filter (Figure 1, Appendix B).

5.2.2 PCM Cassette Requirements

NIOSH Method 7400, PCM involves using a 0.8 to 1.2 µm mixed cellulose ester membrane, 25 mm diameter, 50 mm conductive cowl on cassette (Figure 2, Appendix B). Some labs are able to perform PCM and TEM analysis on the same filter; however, this should be discussed with the laboratory prior to sampling.

5.3 Other Equipment

- Inert tubing with glass cyclone and hose barb
- Whirlbags (plastic bags) for cassettes
- Tools - small screw drivers
- Container - to keep samples upright
- Generator or electrical outlet (may not be required)
- Extension cords (may not be required)
- Multiple plug outlet
- Sample labels
- Air data sheets
- Chain of Custody records

6.0 REAGENTS

Reagents are not required for the preservation of asbestos samples.

7.0 PROCEDURES

7.1 Air Volumes and Flow Rates

Sampling volumes are determined on the basis of how many fibers need to be collected for reliable measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location.

Since the concentration of airborne aerosol contaminants will have some effect on the sample, the following is a suggested criteria to assist in selecting a flow rate based on real-time aerosol monitor (RAM) readings in milligrams/cubic meter (mg/m^3).

	Concentration	Flow Rate
Low RAM readings:	<6.0 mg/m^3	11-15. L/min
Medium RAM readings:	>6.0 mg/m^3	7.5 L/min
High RAM readings:	>10. mg/m^3	2.5 L/min

In practice, pumps that are available for environmental sampling at remote locations operate under a maximum load of approximately 12 L/min.

7.1.1 U.S. EPA's Superfund Method

The Superfund Method incorporates an indirect preparation procedure to provide flexibility in the amount of deposit that be can be tolerated on the sample filter and to allow for the selective concentration of asbestos prior to analysis. To minimize contributions to background contamination from asbestos present in the plastic matrices of membrane filters while allowing for sufficient quantities of asbestos to be collected, this method also requires the collection of a larger volume of air per unit area of filter than has traditionally been collected

for asbestos analysis. Due to the need to collect large volumes of air, higher sampling flow rates are recommended in this method than have generally been employed for asbestos sampling in the past. As an alternative, samples may be collected over longer time intervals. However, this restricts the flexibility required to allow samples to be collected while uniform meteorological conditions prevail.

The sampling rate and the period of sampling should be selected to yield as high a sampled volume as possible, which will minimize the influence of filter contamination. Wherever possible, a volume of 15 cubic meters (15,000 L) shall be sampled for those samples intended for analysis only by the indirect TEM preparation method (Phase 1 samples). For those samples to be prepared by both the indirect and the direct specimen preparation methods (Phase 2 samples), the volumes must be adjusted so as to provide a suitably-loaded filter for the direct TEM preparation method. One option is to collect filters at several loadings to bracket the estimated optimum loading for a particular site. Such filters can be screened in the laboratory so that only those filters closest to optimal loading are analyzed. It has been found that the volume cannot normally exceed 5 cubic meters (5000 L) in an urban or agricultural area, and 10 cubic meters (10,000 L) in a rural area for samples collected on a 25 mm filter and prepared by a direct-transfer technique.

An upper limit to the range of acceptable flow rates for this method is 15 L/min. At many locations, wind patterns exhibit strong diurnal variations. Therefore, intermittent sampling (sampling over a fixed time interval repeated over several days) may be necessary to accumulate 20 hours of sampling time over constant wind conditions. Other sampling objectives also may necessitate intermittent sampling. The objective is to design a sampling schedule so that samples are collected under uniform conditions throughout the sampling interval. This method provides for such options. Air volumes collected on Phase I samples are maximized (<16 L/min). Air volumes collected on Phase 2 samples are limited to provide optimum loading for filters to be prepared by a direct-transfer procedure.

7.1.2 U.S. EPA's Modified Yamate Method for TEM

U.S. EPA's TEM method requires a minimum volume of 560 L and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1200 L to 1800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area of a 25 mm (385 sq mm) and 37 mm (855 sq mm) differ.

7.1.3 NIOSH Method for TEM and PCM

The minimum recommended volume for TEM and PCM is 400 L at 0.1 fiber/cc. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (700 to 2800 L) is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres i.e., areas with high levels of asbestos, require smaller sample volumes (<400 L) to obtain countable samples.

In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If > 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration. Do not exceed 0.5 mg total dust loading on the filter.

7.2 Calibration Procedures

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, (e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator) with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

A rotameter can be used provided it has been recently precalibrated with a primary calibrator. Three separate constant flow calibration readings should be obtained both before sampling and after sampling. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used shall provide a non-fluctuating air-flow through the filter, and shall maintain the initial volume flow-rate to within ± 10% throughout the sampling period. The mean value of these flow-rate measurements shall be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling shall be terminated. Flexible tubing is used to connect the filter cassette to the sampling pump.Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

7.2.1 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. See Manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 3, Appendix B) using a sampling pump, electronic calibrator, and a representative filter cassette. The same lot sampling cassette used for sampling should also be used for calibrating.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.

4. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

6. Perform the calibration three times until the desired flow rate of ± 5% is attained.

7.2.2 Calibrating a Rotameter with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 4, Appendix B) using a sampling pump, rotameter, and electronic calibrator.

3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6 ^{o} vertical.

4. Turn the electronic calibrator and sampling pump on.

5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

7. Record the electronic calibrator flow rate reading and the corresponding rotameter reading. Indicate these values on the rotameter (sticker). The rotameter should be able to work within the desired flow range. Readings can also be calibrated for 10 cm^3 increments for Low Flow rotameters, 500 cm^3 increments for medium flow rotameters and 1 liter increments for high flow rotameters.

8. Perform the calibration three times until the desired flow rate of ± 5% is attained. Once on site, a secondary calibrator, i.e., rotameter may be used to calibrate sampling pumps.

7.2.3 Calibrating a Personal Sampling Pump with a Rotameter

1. See manufacturer's manual for Rotameter's Operational Instructions.

2. Set up the calibration train as shown in (Figure 5, Appendix B) using a rotameter, sampling pump, and a representative sampling cassette.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the rotameter.

4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6 ^{o} vertical.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the precalibrated flow rate value. A sticker on the rotameter should indicate this value.

7. A verification of calibration is generally performed on-site in the clean zone immediately prior to the sampling.

7.3. Meteorology

It is recommended that a meteorological station be established. If possible, sample after two to three days of dry weather and when the wind conditions are at 10 mph or greater. Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly important when monitoring for asbestos downwind from a fixed source.

7.4 Ambient Sampling Procedures

7.4.1 Pre-site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).

3. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety plan.

4. Once on-site the calibration is performed in the clean zone. The calibration procedures are listed in Section 7.2.

5. After calibrating the sampling pump, mobilize to the sampling location.

7.4.2 Site Sampling

1. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap (Figure 6 and 7, Appendix B). The cassette should be positioned downward, perpendicular to the wind

2. If AC or DC electricity is required then turn it on. If used, the generator should be placed 10 ft. downwind from the sampling pump.

3. Record the following in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

4. Turn the pump on. Should intermittent sampling be required, sampling filters must be covered between active periods of sampling. To cover the sample filter: turn the cassette to face upward, place the cassette cap on the cassette, remove the inlet plug from the cassette cap, attach a rotameter to the inlet opening of the cassette cap to measure the flow rate, turn off the sampling pump, place the inlet plug into the inlet opening on the cassette cap. To resume sampling: remove the inlet plug, turn on the sampling pump, attach a rotameter to measure the flow rate, remove the cassette cap, replace the inlet plug in the cassette cap and invert the cassette, face downward and perpendicular to the wind.

5. Check the pump at sampling midpoint if sampling is longer than 4 hours. The generators may need to be regased depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

6. At the end of the sampling period, orient the cassette up, turn the pump off.

7. Check the flow rate as shown in Section 7.2.3. When sampling open-faced, the sampling cap should be replaced before post calibrating. Use the same cassette used for sampling for post calibration (increase dust/fiber loading may have altered the flow rate.

8. Record the post flow rate.

9. Record the cumulative time or run.

10. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.

7.4.3. Post Site Sampling

1. Follow handling procedures in Section 3.2, steps 1-4.

2. Obtain an electronic or hard copy of meteorological data which occurred during the sampling event. Record weather: wind speed, ambient temperature, wind direction, and precipitation. Obtaining weather data several days prior to the sampling event can also be useful.

7.5 Indoor Sampling Procedures

PCM analysis is used for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM (U.S. EPA's Modified Yamate Method) is used to identify asbestos from non-asbestos fibers.

Sampling pumps should be placed four to five feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. Refer to Table 2 (Appendix A) for a summary of indoor sampling locations and rationale for selection.

Indoor sampling utilizes high flow rates to increased sample volumes (2000 L for PCM and 2800 to 4200 L for TEM) in order to obtain lower detection limits below the standard, (i.e., 0.01 f/cc or lower [PCM] and 0.005 structures/cc or lower [TEM]).

7.5.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past, an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The results from this sampling option typifies worst case condition. This is referred to as aggressive air sampling for asbestos. Refer to Table 2 for sample station locations.

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1000 sq. ft. of floor.

2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.

3. Follow procedures in Section 7.4.1 and 7.4.2 (Turn off the pump and then the fan(s) when sampling is complete.).

4. Follow handling procedures in Section 3.2, steps 1-4.

8.0 CALCULATIONS

The sample volume is calculated from the average flow rate of the pump multiplied by the number of minutes the pump was running (volume = flow rate X time in minutes). The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample (zero for lot, field and trip blanks).

The concentration result is calculated using the sample volume and the numbers of asbestos structures reported after the application of the cluster and matrix counting criteria.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Follow all QA/QC requirements from the laboratories as well as the analytical methods.

9.1 TEM Requirements

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine whether there is contamination by extraneous asbestos structures during specimen preparation.

3. Examine of laboratory blanks to determine if contamination is being introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters shall be examined. Reference filters should be maintained as part of the laboratory's Quality Assurance program.

5. To minimize subjective effects, some specimens should be recounted by a different microscopist.

6. Asbestos laboratories shall be accredited by the National Voluntary Laboratory Accreditation Program.

7. At this time, performance evaluation samples for asbestos in air are not available for Removal Program Activities.

9.2 PCM Requirements

1. Examine reference slides of known concentration to determine the analyst's ability to satisfactorily count fibers. Reference slides should be maintained as part of the laboratory's quality assurance program.

2. Examine field blanks to determine if there is contamination by extraneous structures during sample handling.

3. Some samples should be relabeled then submitted for counting by the same analyst to determine possible bias by the analyst.

4. Participation in a proficiency testing program such as the AIHA-NIOSH proficiency analytical testing (PAT) program.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures. More specifically, when entering an unknown situation involving asbestos, a powered air purifying respirator (PAPR) (full face-piece) is necessary in conjunction with HEPA filter cartridges. See applicable regulations for action level, PEL, TLV, etc. If previous sampling indicates asbestos concentrations are below personal health and safety levels, then Level D personal protection is adequate.

12.0 REFERENCES

(1) Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air, Part 1: Method, EPA/540/2-90/005a, May 1990, and Part 2: Technical Background Document, EPA/540/2-90/005b, May 1990.

(2) Methodology for the Measurement of Airborne Asbestos by Electron Microscopy, EPA's Report No. 68-02-3266, 1984, G. Yamate, S.C. Agarwal, and R. D. Gibbons.

(3) National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method. Third Edition. 1987.

(4) U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 763. July 1, 1987. Code of Federal Regulations 40 CFR 763 Addendum. October 30, 1987.

(5) U.S. Environmental Protection Agency . Asbestos-Containing Materials in Schools ; Final Rule and Notice. 52 FR 41826.

(6) Occupational Safety and Healt h Administration. Code of Fede ral Regulations 29 CFR 1910.1001. Washington, D.C . 1987.

APPENDIX A

Tables

TABLE 1. SAMPLE STATIONS FOR OUTDOOR SAMPLING		
Sample Station Location	Sample Numbers	Rationale
Upwind/Background [1]	Collect a minimum of two simultaneous upwind/background samples 30 º apart from the prevailing windlines.	Establishes background fiber levels.
Downwind	Deploy a minimum of 3 sampling stations in a 180 degree arc downwind from the source.	Indicates if asbestos is leaving the site.
Site Representative and/or Worst Case	Obtain one site representative sample which shows average condition on-site or obtain worst case sample (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

[1] More than one background station may be required if the asbestos originates from different sources.

APPENDIX A (Cont'd)

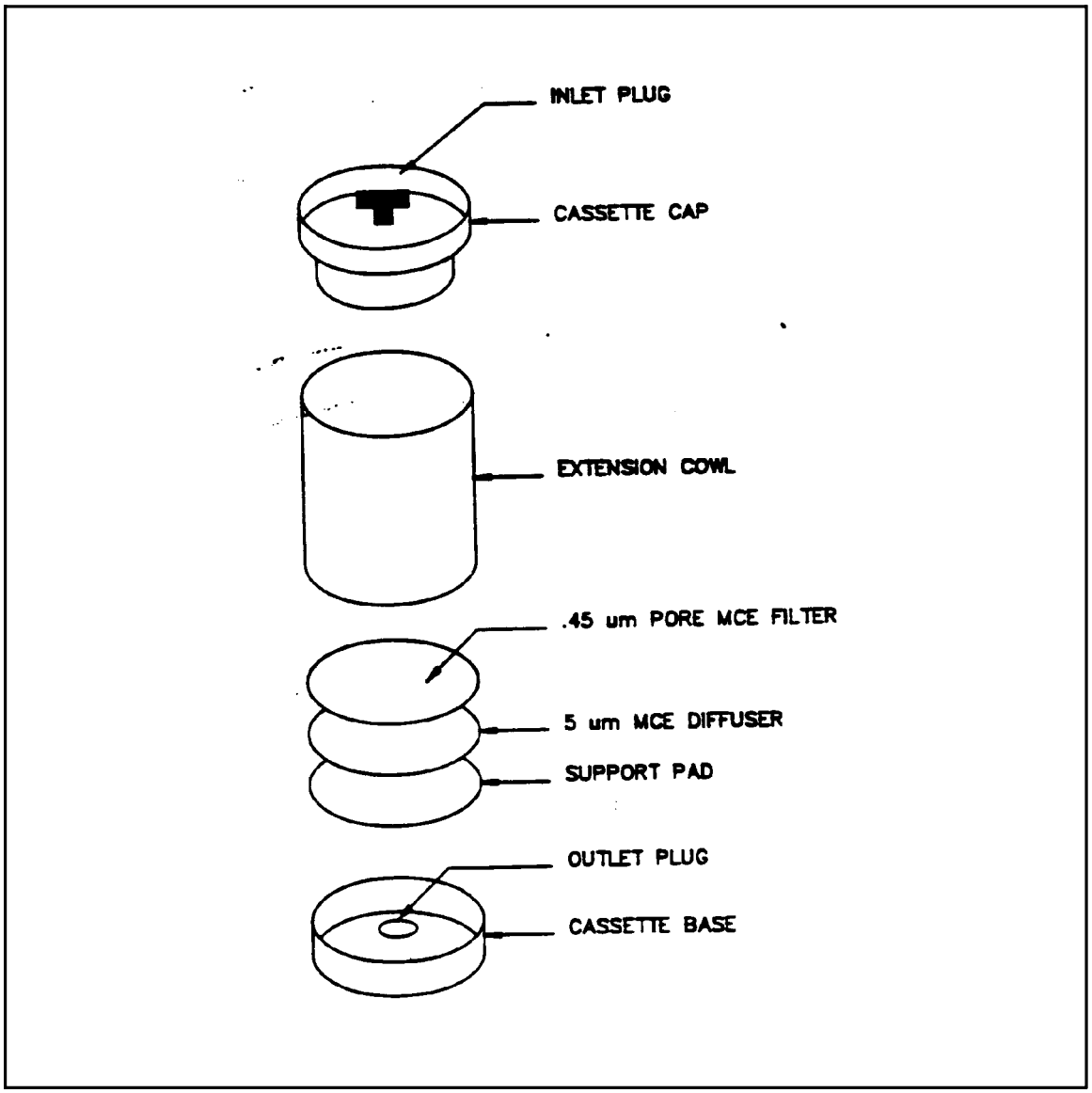
Tables

TABLE 2 SAMPLE STATIONS FOR INDOOR SAMPLING		
Sample Station Location	Sample Numbers	Rationale
Indoor Sampling	If a work site is a single room, disperse 5 samplers throughout the room. If the work site contains up to 5 rooms, place at least one sampler in each room. If the work site contains more than 5 rooms, select a representative sample of the rooms.	Establishes representative samples from a homogeneous area.
Upwind/Background	If outside sources are suspected, deploy a minimum of two simultaneous upwind/background samples 30 ^{o} apart from the prevailing windlines.	Establish whether indoor asbestos concentrations are coming from an outside source.
Worst Case	Obtain one worst case sample, i.e., aggressive sampling (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

APPENDIX B

Figures

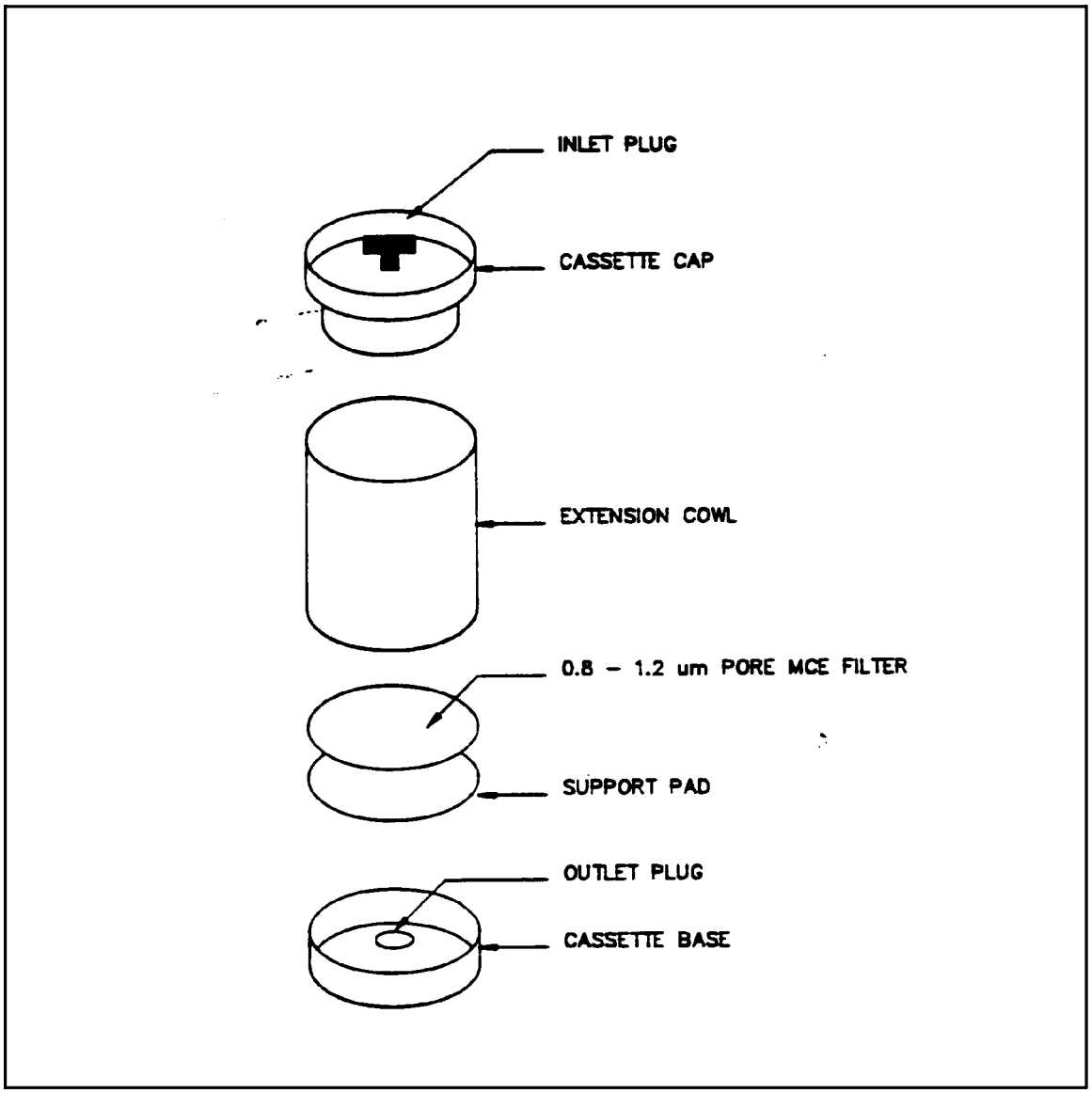
FIGURE 1. Transmission Electron Microscopy Filter Cassette



APPENDIX B (Cont'd)

Figures

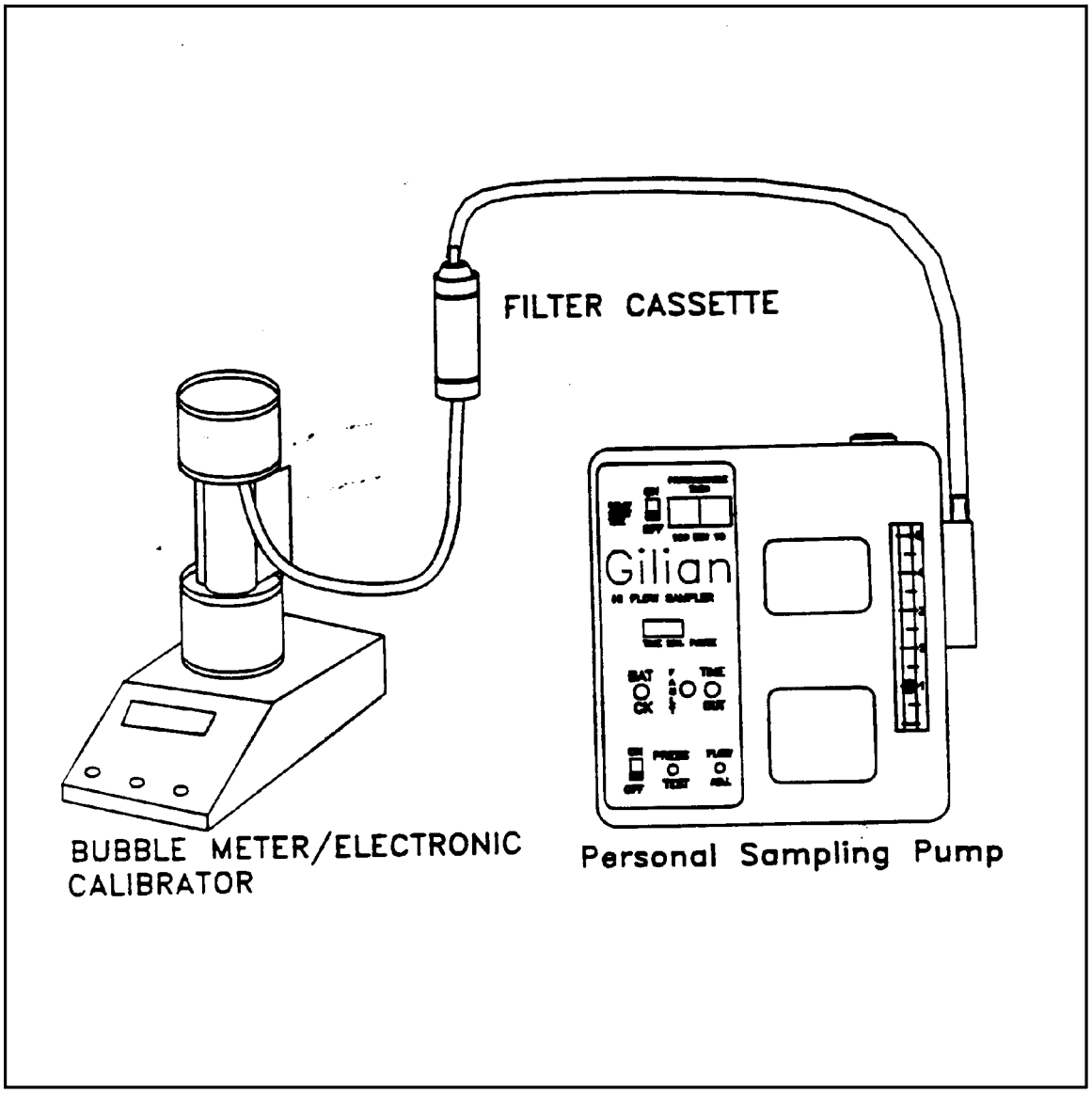
FIGURE 2. Phase Contrast Microscopy Filter Cassette



APPENDIX B (Cont'd)

Figures

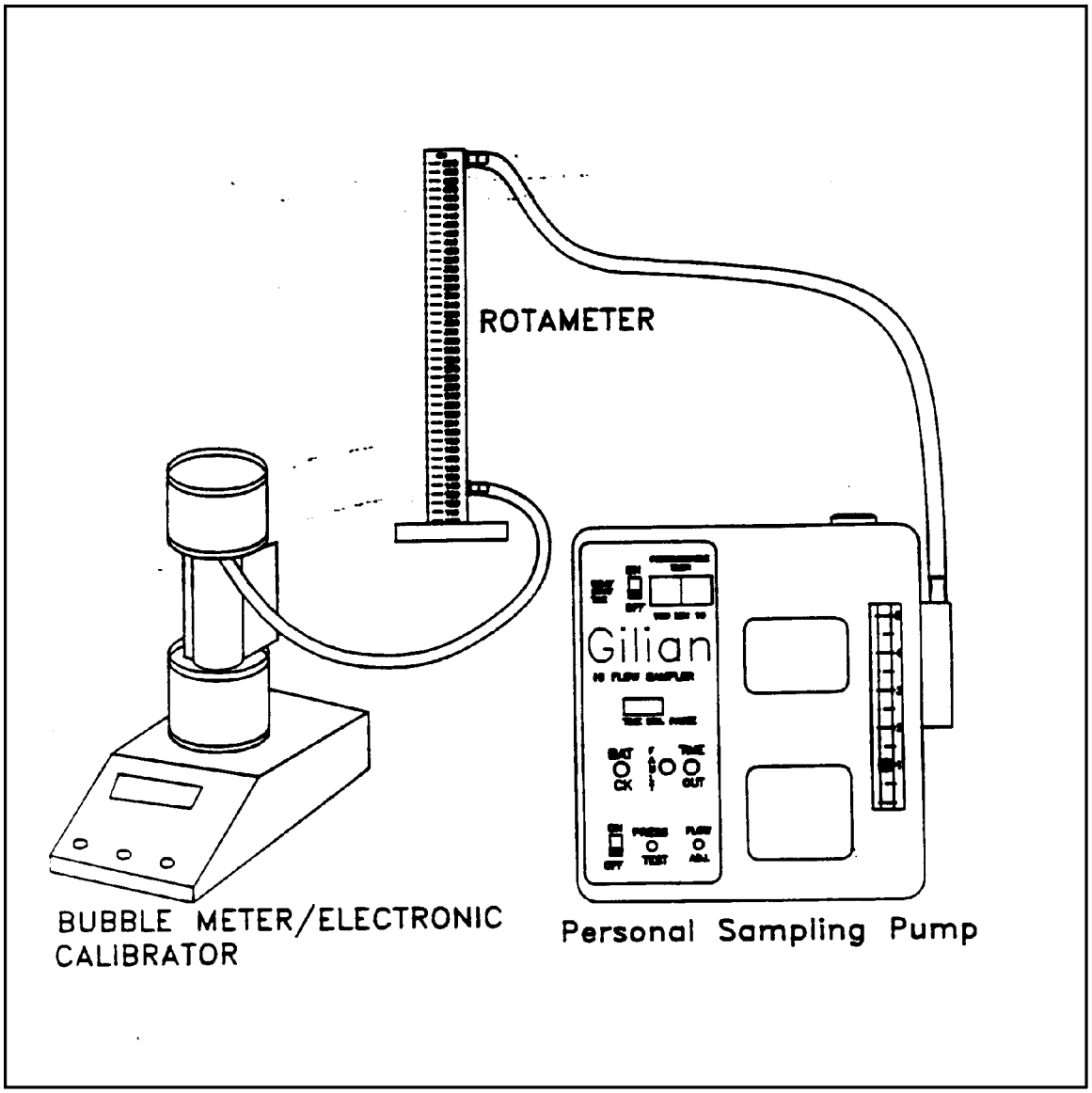
FIGURE 3. Calibrating a Personal Sampling Pump with a Bubble Meter



APPENDIX B (Cont'd)

Figures

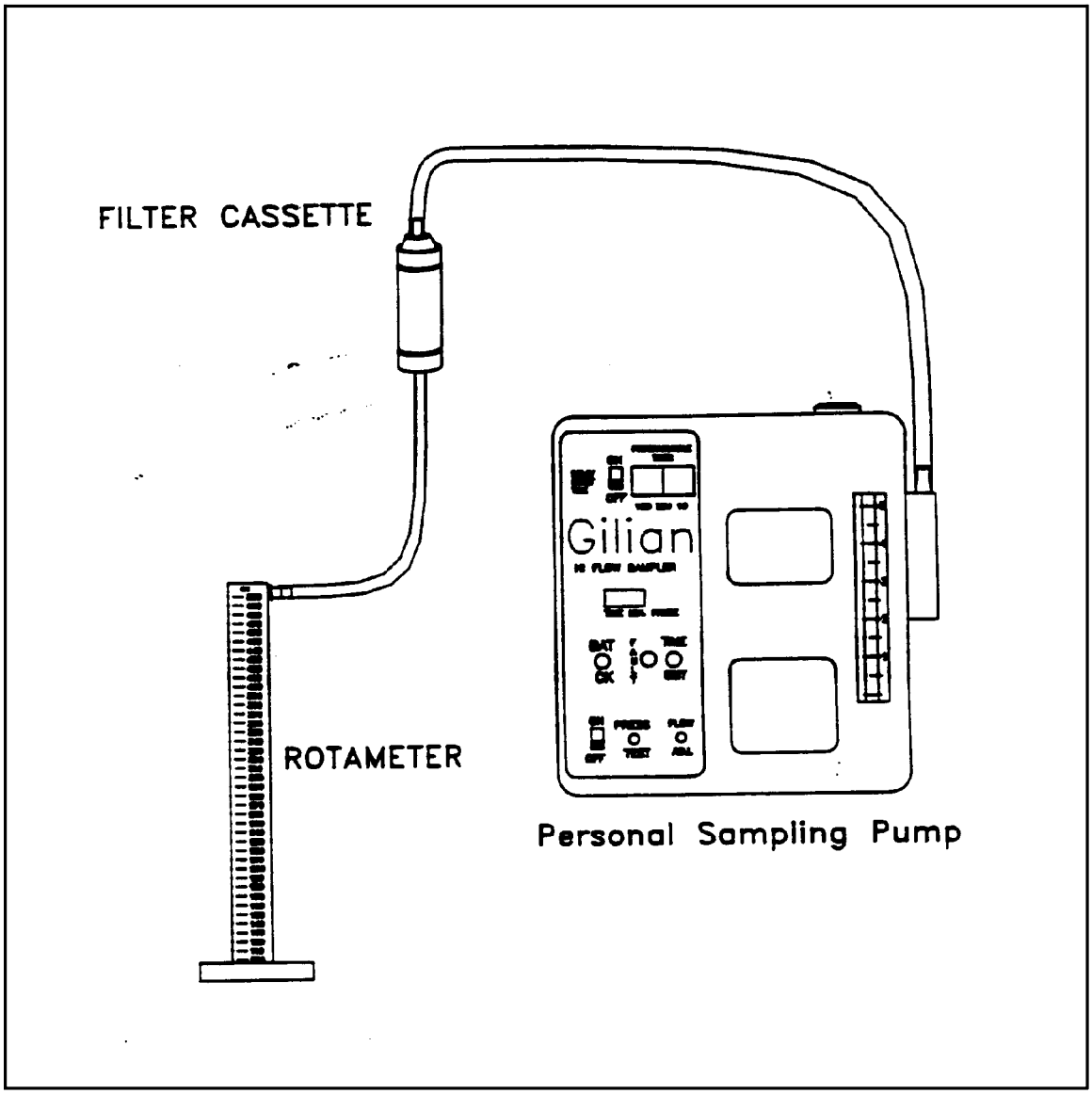
FIGURE 4. Calibrating a Rotameter with a Bubble Meter



APPENDIX B (Cont'd)

Figures

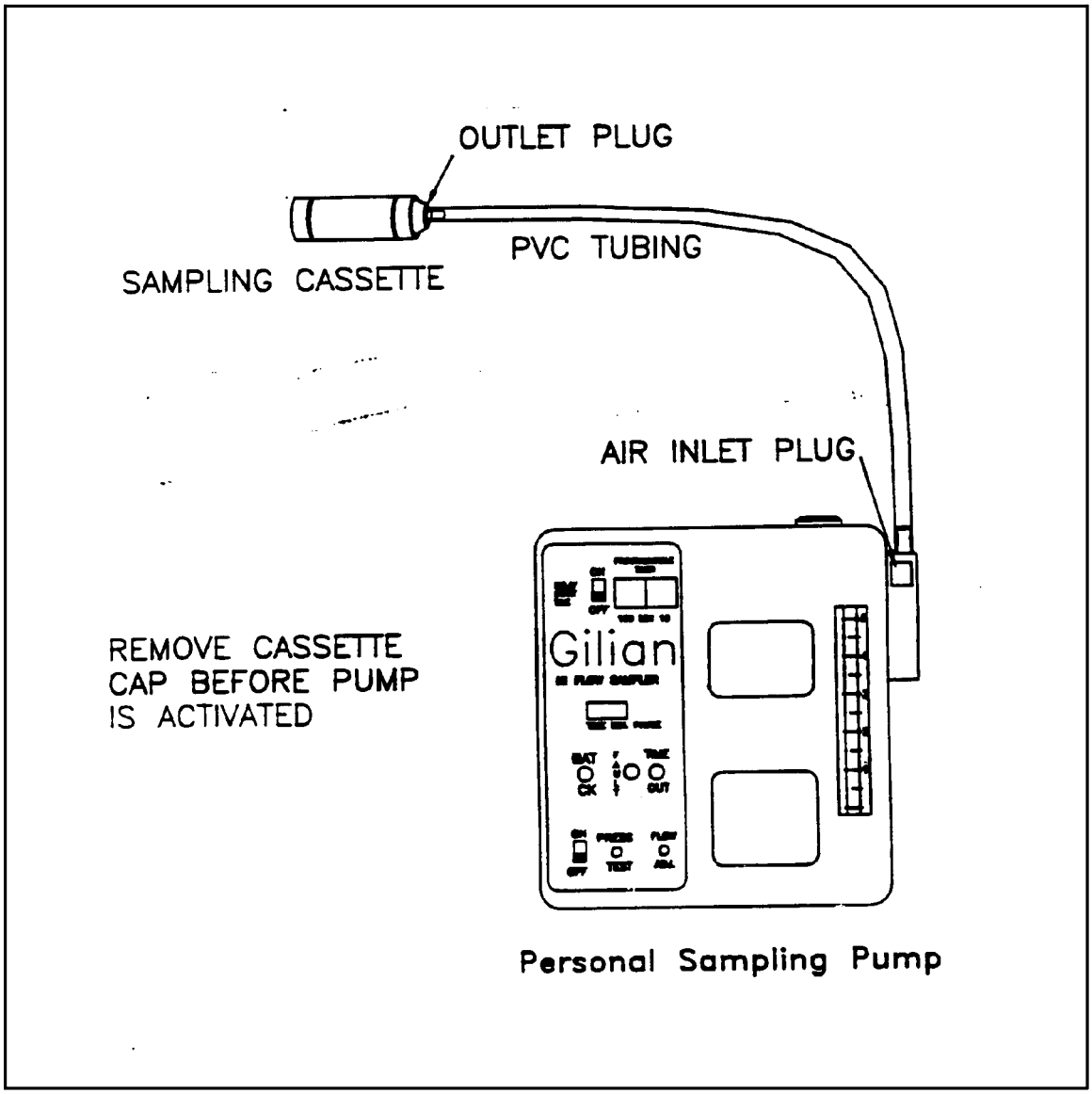
FIGURE 5. Calibrating a Sampling Pump with a Rotameter



APPENDIX B (Cont'd)

Figures

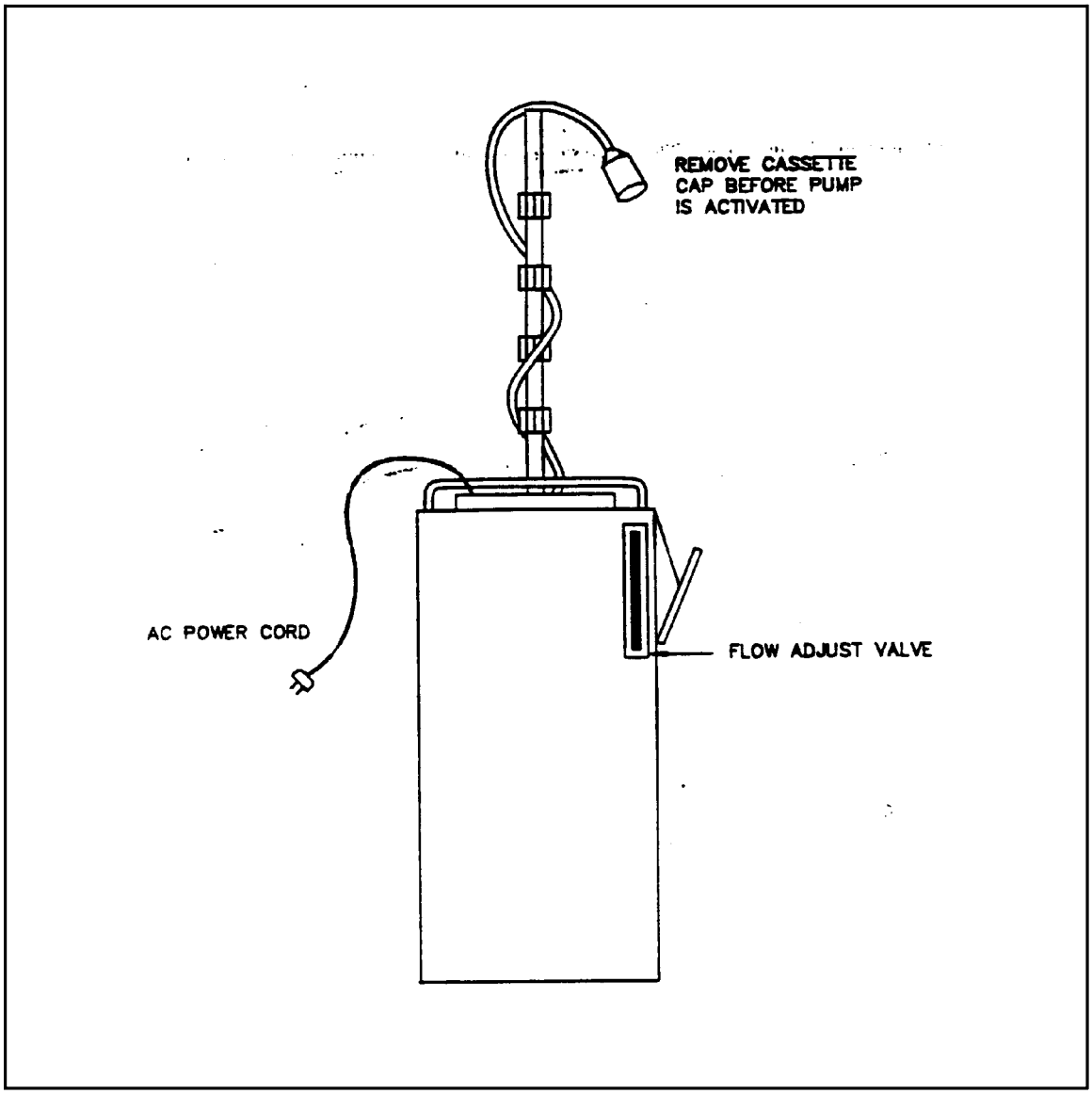
FIGURE 6. Personal Sampling Train for Asbestos



APPENDIX B (Cont'd)

Figures

FIGURE 7. High Flow Sampling Train for Asbestos



APPENDIX F

SOP EPA-LIBBY-09 (REV 1)
AND
GRID OPENINGS CALCULATION

Date: March 5, 2008 SOP No. EPA-LIBBY-09 (rev 1)

Title: STANDARD OPERATING PROCEDURE FOR TEM DATA REVIEW AND DATA ENTRY VERIFICATION

Author Lynn Woodbury, Syracuse Research Corporation (SRC)

SYNOPSIS: This standard operating procedure provides a standardized method for review of raw TEM data and verification of entry of TEM results into the Libby2 Database. Steps included in this SOP are: a) selection of TEM analyses for review and verification, b) review of the original laboratory TEM bench sheets, and c) verification of the transfer of results from the bench sheets into the Libby2 Database. This method is applicable for use only at the Libby Superfund Site.

APPROVALS:

TEAM MEMBER	**SIGNATURE/TITLE**	**DATE**
EPA, Region 8		
SRC		

Revision	Date	Reason for Revision
0	12/7/06	--
1	3/5/08	▪ Modify selection procedure to exclude: 1) records associated with files uploaded due to error corrections, and 2) samples that will be validated under other review efforts. ▪ Modify SOP to include a check of samples with errors to ensure that corrections were made properly. ▪ Change review time period from monthly to quarterly. ▪ Add consistency review of data entered in accord with LB-000066. ▪ Refer to LB-000016 (ISO) and LB-000031 (AHERA/ASTM) for appropriate aspect ratio recording rules.

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide a standardized method for review of raw transmission electron microscopy (TEM) data and verification of entry of TEM results into the Libby2 Database. Steps included in this SOP are: a) selection of TEM analyses that will undergo a data consistency review and verification, b) performing a consistency review of the original laboratory TEM bench sheets to verify that TEM analysts working on the Libby project are performing analyses in accord with project-specific recording rules, and c) verifying the correct transfer of results from the bench sheets into the Libby2 Database.

2.0 PERSONNEL QUALIFICATIONS

Personnel performing data review and verification under this SOP must be skilled and/or trained in interpretation of raw data sheets and electronic data files in support of TEM analysis for the Libby Superfund Site. Personnel must be well-versed in TEM counting rules and Libby project-specific counting and recording rules in order to perform the required consistency reviews.

3.0 APPLICABILITY

A representative portion of TEM data, analyzed for the Libby Superfund Site, will be selected for review and verification to ensure consistency in data collection and data entry. The frequency of samples selected for review is discussed in subsequent sections.

4.0 SELECTION OF TEM RECORDS FOR REVIEW

The goals for selecting a representative subset of TEM results for review and verification are provided below. Selections should be made to ensure representation across several areas: 1) the fraction of total samples analyzed by TEM; 2) the types of programs (SAPs, QAPPs, etc.) carried out at the Site; 3) the laboratories performing TEM analysis.

> Total Samples. Over the course of the Libby project (that begins with the date of this approved SOP), a minimum of ten percent (10%) of all TEM analyses should be selected for review and verification. Samples will be selected in a manner that ensures representation across the different types of programs and the laboratories performing the TEM analysis.
>
> Types of Programs. If there are important differences in sampling and analysis protocols between sampling programs, data reviews and verifications will be stratified by program. At the request of EPA, the frequency of data review may be increased for specific programs of interest (i.e., investigative samples associated with ambient air monitoring, activity-based sampling, and cleanup efficacy evaluations). Of specific interest is ensuring reviews are stratified across programs that reflect differences in structure recording and/or counting rules.
>
> Laboratories performing TEM analysis. Data reviews and verifications will be performed for each laboratory participating in TEM analysis in support of the Site sampling programs.

Specific details for selecting TEM records for review are outlined below.

1. Interlab samples will be selected on a quarterly basis – 1st Quarter = January 1 - March 31, 2nd Quarter = April 1 - June 30, 3rd Quarter = July 1 - September 30, 4th Quarter = October 1 - December 31. At the beginning of each quarterly review period, compile a list of all TEM ISO 10312 and all TEM AHERA/ASTM samples for which new results were uploaded into the Libby2 Database in the preceding quarter (e.g., for the 1st

Quarter, specify a date range of January 1 - March 31). Samples will be selected for review separately for TEM ISO 10312 and AHERA/ASTM.

The Libby2 Database query will be based on the analysis upload date rather than the analysis date to ensure that analyses with an upload in a different quarter as the analysis date are not excluded. For example, consider the case where the TEM ISO 10312 analysis for sample X-12345 was performed on September 22 (in the 3rd Quarter) and the results were uploaded on October 3 (in the 4th Quarter). The selection query performed on October 1 for the 3rd Quarter results, if limited to all results analyzed from July 1 - September 30, would not capture the results for X-12345 because they had not yet been uploaded. The selection query performed on January 1 for the 4th Quarter results, if limited to all results analyzed from October 1 - December 31, would also not capture the results for sample X-12345 because the analysis date is outside of the specified range.

However, use of the analysis upload date has the potential to include both new analyses and corrections to older analyses resulting from earlier validation efforts. To avoid having to re-review analyses that have already been validated and corrected, only new analyses should be selected for review. To do this, the list of candidate samples will be compared to a running list of all previously validated samples[a]. Any samples that have been validated previously will be excluded from selection. In addition, samples that will be validated under other review efforts associated with specific investigations (e.g., ambient air) will also be excluded from selection.

2. A minimum of 10% of all TEM ISO 10312 and TEM AHERA/ASTM analyses will be selected for review each quarter. To the extent practical, these will be first stratified by analyst, with the number of samples from each analyst being in proportion to the total number of samples analyzed by each analyst. If there are important differences between sampling programs (e.g., differences in counting and/or recording protocols), samples will also be stratified by program. In addition, samples will be stratified according to detect/non-detect, with approximately 50% of the samples selected being detects, and 50% being non-detects. The following table illustrates the selection process:

	Analyzed			Selected		
Analyst	Detect	ND	Total	Detect	ND	Total
1	14	112	126	11	6	17
2	20	421	441	16	22	38
3	2	4	6	2	1	3
4	0	8	8	0	1	1
Total	36	545	581	29	30	59

	Goal	Actual
Total	58	59
Detect	29	29
Non-detect	29	30

In this example, there are a total of 581 new TEM ISO 10312 analyses available for the quarter (36 detects + 545 non-detects), analyzed by four analysts. Thus, the total number of TEM ISO 10312 analyses to be selected for review is 10% · 581 = 58.1 (rounded to 58). This total is to be split evenly between detects (29) and non-detects

[a] This running list of all validated samples will include validation efforts associated with specific investigations (e.g., 2006 demolition investigation, ambient air investigation, SQAPP sampling), as well as TEM validation efforts from preceding quarters.

(29). The number of detects and non-detects selected per analysis is calculated by multiplying the target number (29) by the fraction of the total detects and non-detects evaluated by the analyst. For example, for Analyst 1:

Number of detects = 29 · (14/36) = 11.3 (rounded to 11)
Number of non-detects = 29 · (112/545) = 5.9 (rounded to 6)

If an analyst has analyzed at least one sample in a category (detect or non-detect), the minimum number of samples to be selected is one. For example, for Analyst 4, the number of detects analyzed is zero, so the number of detects selected is zero. For non-detects, the number to be selected (computed using the approach above) is:

Number of non-detects = 29 · (8/545) = 0.4 (rounded to 0)

In this case, the number selected is set to the minimum of 1.

As seen, this procedure will tend to select a higher proportion of detects (29 of 36 analyses, 81%) than non-detects (30 of 545 analyses, 6%). This approach is used because it is considered likely that the incidence of errors may tend to be higher in samples with one or more detected structures than in samples with no detected structures.

3. Stratify the list of newly uploaded samples according to program (if applicable), analyst, and detection status (detect, non-detect), and select the appropriate number of samples for each category at random.

4. Based on the samples selected for review, create a list of all the unique analytical laboratory jobs which will be needed to review the selected analyses. Submit the list of analytical laboratory jobs to EPA's project file manager (Volpe).

5. Volpe will provide SRC with electronic copies (as Adobe Acrobat PDFs) of the requested analytical laboratory jobs via CD, an FTP site, or another electronic transfer mechanism.

5.0 CONSISTENCY REVIEW OF LABORATORY BENCH SHEETS

The purpose of the consistency review is to inspect data entered on the laboratory bench sheets in order to identify the occurrence of any data omissions, apparent inconsistencies, or potential errors in structure.

5.1 Consistency Review Procedure for TEM ISO 10312

1. For each TEM ISO 10312 analysis to be reviewed, locate the original hand-written laboratory bench sheet(s) within the appropriate laboratory job.

2. Review the original hand-written laboratory bench sheets to determine if the raw structure data are recorded in accord with ISO 10312 counting rules (as modified in Libby Laboratory Modification LB-000016). The types of information that will be reviewed include:

   - The recorded structure types are consistent with the counting rules. Valid structure types include F, B, CC, CD, CF, CR, MC, MD, MF, and MR.

   - Disperse complex structures are broken down in accord with ISO 10312 counting rules and compact complex structures are not broken down. For example, a CD43 should provide 4 secondary structures, with 3 secondary structures greater than 5 um. In this example, the structure type for each of the recorded secondary structures should begin with the "C" prefix (e.g., CF, CB, CR).

- The primary and total columns have been populated with non-zero numbers for all countable structures and a zero for all non-countable structures.

- If recorded, all non-asbestos mineral (NAM) structures are identified as non-countable structures.

- All recorded fibers (F, CF, and MF) meet the appropriate aspect ratio requirement. [See Libby Laboratory Modification LB-000016 for aspect ratio recording rules for ISO 10312.]

- The mineral class is populated for all structures.

- If Libby Laboratory Modification LB-000066 is applicable, the mineral type (e.g., WRTA) and appropriate spectra code (e.g., NaK) is recorded in the structure comment field for all recorded LA, OA, and NAM structures.

- Structure comments (e.g., < 3:1) are supported by recorded data.

- The stored values in the Libby2 Database for primary, total, structure type, length, width, and mineral class match the original bench sheet.

5.2 Consistency Review Procedure for TEM AHERA/ASTM

1. For each TEM AHERA/ASTM analysis to be reviewed, locate the original hand-written laboratory bench sheet(s) within the appropriate laboratory job.

2. Review the original hand-written laboratory bench sheets to determine if the raw structure data are recorded in accord with AHERA/ASTM counting rules (as modified in Libby Laboratory Modification LB-000031). The types of information that will be reviewed include:

    - The recorded structure types are consistent with the counting rules. For AHERA/ASTM, valid structure types include F, B, M, and C.

    - The total column has been populated with non-zero numbers for all countable structures and a zero for all non-countable structures.

    - If recorded, all non-asbestos mineral (NAM) structures are identified as non-countable structures.

    - The recorded structures meet the counting rule requirements. For AHERA/ASTM, all recorded fibers and matrices meet the appropriate aspect ratio requirement. [See Libby Laboratory Modification LB-000031 for aspect ratio recording rules for AHERA/ASTM.]

    - The recorded dimensions for matrices are the protrusion dimensions, not the matrix dimensions (provided sketches will be used to qualitatively assess dimensions).

    - The mineral class is populated for all structures.

    - If Libby Laboratory Modification LB-000066 is applicable, the mineral type (e.g., WRTA) and appropriate spectra code (e.g., NaK) is recorded in the structure comment field for all recorded LA, OA, and NAM structures.

    - Structure comments (e.g., < 5:1) are supported by recorded data.

- The stored values in the Libby 2 Database for primary, total, structure type, length, width, and mineral class match the original bench sheet.

5.3 Corrective Action

The data reviewer will prepare a list of any apparent inconsistencies, omissions, or other suspected errors. This list will be provided to EPA and to the Libby laboratory coordinator (CDM), who will forward the list to the appropriate laboratories and analysts for review and response.

At the laboratory, the analyst that performed the analysis and the Quality Assurance (QA) personnel that signed off on the TEM electronic data deliverable (EDD) will review the issues identified and determine which of the issues identified are authentic errors that require correction. All errors will be corrected and a revised TEM EDD and/or hard copy bench sheet will be submitted to the Libby laboratory coordinator (CDM). Each laboratory will provide re-training for analysts and QA reviewers, as needed, to minimize the occurrence of errors at the level of the bench sheet and EDD.

6.0 VERIFICATION OF DATA TRANSFER FROM BENCH SHEET TO DATABASE

6.1 Verification Procedure

The purpose of verification is to ensure that the data from the bench sheet have been transferred into the Libby 2 Database without error or omission. The following steps will be performed as part of the data verification procedure.

1. Compare the analysis-specific information provided in the Libby2 Database to the original lab job documentation (e.g., internal laboratory chain of custody, preparation logs, etc.). [Note: Whenever possible, verification will be performed against hand-written notations, NOT internal laboratory summary tables prepared from hand-written notes. Every attempt should be made to obtain the original hand-written notes. If laboratory summary tables are used instead of hand-written notes, this should be documented and specific rationale should be provided.] The following fields will be verified:

    - Analysis Method (TEM-ISO10312, TEM-AHERA, ASTM)
    - Analysis Date
    - Lab Name
    - Lab Job Number
    - Lab Sample Number
    - Preparation Method (Direct, Indirect, or Indirect with Ashing)
    - Filter Status (Analyzed, Overloaded, Damaged, Missing, Cancelled)
    - Primary Effective Filter Area (EFA, mm^2)
    - Secondary EFA (mm^2) [For indirect preparations only]
    - Grid Opening Area (Ago, mm^2) [b]
    - F-factor [For indirect preparations only, direct prep F-factor = 1]
    - Air Volume (L) or Sample Area (cm^2) [c]
    - Analysis Comments

[b] If the grid opening area is not within the expected range (0.005 - 0.015 mm^2), the value should be confirmed with the laboratory.
[c] To account for potential rounding issues, if the reported analysis air volume or sample area different from the value reported for the sample but is within 0.5% this will be noted in the summary report, but the value will be considered to be correct.

2. Verify the calculation of the F-factor for indirect preparations as follows:

   F-factor = Fraction of primary filter used · Volume of resuspension fluid applied to secondary filter / Total resuspension volume

3. Verify the amphibole sensitivity recorded in the Libby2 Database as follows:

   Air Sensitivity = EFA / (GOx · Ago · V · 1000 · F-factor)
   Dust Sensitivity = EFA / (GOx · Ago · SA · F-factor)

   where: EFA = Effective Filter Area (mm^2) [d]
   GOx = Grid Openings Counted for Libby amphibole
   Ago = Area of a Grid Opening (mm^2)
   V = Air Volume (L)
   SA = Dust Sample Area (cm^2)
   F-factor = indirect preparation dilution factor

4. Count the total number of unique grid openings evaluated in the original hand-written laboratory bench sheets, and compare to the number in the field titled "AnalysisGOCounted" in the Libby2 Database. [Note: If more than one analysis has been performed for the same sample, determine if the grid openings recorded in the second analysis were inclusive or exclusive of the grid openings in the first analysis. This check helps identify cases where an updated or revised EDD is added to the database as a new file rather than replacing (overwriting) an old file, thereby resulting in the duplication of some data.]

5. Using the original hand-written laboratory bench sheets, count the total number of "countable" Libby amphibole (LA) structures across all grid openings evaluated, and compare this number with the "binned" LA values stored in the Libby2 Database.

   - For ISO 10312 analyses, LA counts will be compared to Bin G for LA, which is equal to the total number of countable LA.

   - For AHERA/ASTM, LA counts will be compared to the "S<5um" and "S>5um" bins for LA.

6.2 Corrective Action

For each sample where an issue has been identified, the data reviewer will obtain a hard copy of the laboratory bench sheet. Based on a review of the bench sheet, each issue will be classified as either a) an omission or data entry error at the level of the EDD, or b) an error at the level of the data upload from the EDD into the Libby2 Database.

The data reviewer will prepare a list of any noted discrepancies or omissions for each sample, along with the apparent type of error. This list will be provided to EPA and to the Libby laboratory coordinator (CDM) for review and response.

In cases of apparent data omission or error at the level of the EDD preparation, the laboratory coordinator will contact the laboratory and identify the apparent error(s). At the laboratory, the individual responsible for data entry from the bench sheet into the EDD and the QA personnel that signed off on the EDD will review the issue and make corrections to the EDD as needed. If corrections are made, a revised EDD will be submitted to EPA's database manager for re-entry into the Libby 2 Database. Re-training of data entry and QA review personnel may be implemented, as needed.

[d] For direct preparations this will be the primary EFA. For indirect preparations, this will be the secondary EFA.

If the error is due to a database upload error, EPA's database manager (Volpe) will be contacted and notified of the issue. At Volpe, the TEM upload procedure will be reviewed to identify the source of the issue and modified to ensure that future TEM EDDs will be uploaded correctly. Depending on the nature of the issue, it may be necessary to identify other TEM analyses in the Libby 2 Database that would have been similarly impacted. Any potentially impacted TEM analyses should be removed from the Libby2 Database and re-uploaded after the upload procedure has been corrected.

7.0 CHECKING CORRECTIONS

Each quarter, the data reviewer will review the Libby2 Database and the lab job documentation to ensure that the appropriate corrections have been made for all analyses where one or more issues were identified during previous verification efforts. In cases where a revised EDD was uploaded into the database, the data reviewer will ensure that the incorrect EDD has been removed. A comprehensive summary of all issues and their status will be maintained by the data reviewer. As needed, this summary will be provided to EPA's database manager and the Libby laboratory coordinator for follow-up.

8.0 REPORTING

The data reviewer will prepare a report which summarizes the results of the consistency review and data verification for the sample set and identifies areas for improvement. Attachment A provides an example of this report. As seen, this report includes a detailed summary of the consistency review and data verification findings, and includes a summary of the potential implications of the review and verification findings on the data quality and use of the TEM analyses in the Libby2 Database. This report will also provide copies of all electronic spreadsheets generated which track any identified discrepancies and the resolution status of each issue.

Based on the results of the review and verification, EPA may choose to modify (either increase or decrease) the frequency of TEM samples selected for review and verification and/or the selection/review/verification process.

9.0 REFERENCES

Asbestos Hazardous Emergency Response Act (AHERA). 1986. Title 20, Chapter 52, Sec. 4011. Public Law 99-519.

American Society for Testing and Materials (ASTM). 2003. Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations. ASTM D 5755-03. American Society for Testing and Materials. October 2003.

International Organization for Standardization (ISO). 1995. Ambient Air – Determination of asbestos fibres – Direct-transfer transmission electron microscopy method. ISO 10312:1995(E).

ATTACHMENT A

EXAMPLE OF TEM CONSISTENCY REVIEW AND DATA TRANSFER VERIFICATION REPORT

TEM CONSISTENCY REVIEW AND DATA TRANSFER VERIFICATION REPORT

Date: _____ Prepared by: _____

Reporting Date Range: _____

SUMMARY OF FINDINGS AND DATA QUALITY IMPLICATIONS

_____

_____

_____

_____

_____

_____

_____

Recommendations for future review and verification: _____

_____

_____

_____

_____

TEM-ISO 10312 SELECTION AND CONSISTENCY REVIEW RESULTS

Summary of available analyses for date range specified –

Analyst, Lab	Number of TEM-ISO 10312 Analyses			Number of Analyses Selected for Review		
	Detect No	n-Detect	Total	Detect No	n-Detect	Total
Analyst #1, Lab Name						
Analyst #2, Lab Name						
…						
Total						

	Goal	Actual
Selected Total _	_____ _	_____
Selected Detects _	_____ _	_____
Selected Non-Detects	_____	_____

Detailed summary of bench sheet consistency review –

Number of analyses reviewed: _____ (_____% of total analyses selected)

If not all analyses could be reviewed, provide a brief explanation for why: _____

_____

Number of analyses with recording issues identified: _____ (_____% of total analyses reviewed)

Types of recording issues identified (indicate the number of analyses):

_____ Reported structure types are inconsistent with ISO guidance

_____ Primary and/or total columns are not populated correctly

_____ NAM structures are recorded and not identified as non-countable

_____ Fibers recorded as countable do not meet aspect ratio criteria (LB-000016)

_____ Mineral class designation is missing or inconsistent

_____ Structure comments are inconsistent with LB-000066

_____ Structure comments are inconsistent with recorded data

_____ Structure attributes in the database do not match the bench sheet

Do the recording issues identified appear to be associated with a particular analyst or laboratory? Yes No

If yes, identify the analyst and/or laboratory: _____

_____

TEM-AHERA/ASTM SELECTION AND CONSISTENCY REVIEW RESULTS

Summary of available analyses for date range specified –

Analyst, Lab	Number of TEM-AHERA/ASTM Analyses			Number of Analyses Selected for Review		
	Detect No	n-Detect	Total	Detect No	n-Detect	Total
Analyst #1, Lab Name						
Analyst #2, Lab Name						
…						
Total						

	Goal	Actual
Selected Total	_____	_____
Selected Detects	_____	_____
Selected Non-Detects	_____	_____

Detailed summary of bench sheet consistency review –

Number of analyses reviewed: _____ (_____% of total analyses selected)

If not all analyses could be reviewed, provide a brief explanation for why: _____

_____

Number of analyses with recording issues identified: _____ (_____% of total analyses reviewed)

Types of recording issues identified (indicate the number of analyses):

_____ Reported structure types are inconsistent with AHERA/ASTM guidance

_____ Total column is not populated correctly

_____ NAM structures are recorded and not identified as non-countable

_____ Fibers recorded as countable do not meet aspect ratio criteria (LB-000031)

_____ Recorded dimensions for matrices are matrix dimensions not protrusion dimensions

_____ Mineral class designation is missing or inconsistent

_____ Structure comments are inconsistent with LB-000066

_____ Structure comments are inconsistent with recorded data

_____ Structure attributes in the database do not match the bench sheet

Do the recording issues identified appear to be associated with a particular analyst or laboratory? Yes No

If yes, identify the analyst and/or laboratory: _____

_____

DATA TRANSFER VERIFICATION RESULTS

Number of analyses verified[1]: _____ (_____% of total analyses selected)

Number of analyses with data transfer issues identified: _____ (_____% of total analyses verified)

Types of data transfer issues identified:

_____ Incorrect/missing information on analysis details (e.g., lab job number, analysis date, filter status)

_____ F-factor calculation is incorrect or inputs are missing

_____ Air volume or dust area reported by laboratory is inconsistent with field value

_____ Number of grid openings counted is incorrect

_____ Sensitivity calculation is incorrect or inputs are missing

_____ Total number of countable LA structures is incorrect

Do the data transfer issues identified appear to be associated with a particular analyst or laboratory? Yes No

If yes, identify the analyst and/or laboratory: _____

_____

Comments: _____

_____

_____

_____

ISSUE RESOLUTION AND STATUS

_____

_____

_____

_____

_____

_____

[1] Only those analyses that have passed the bench sheet consistency review are included in the data transfer verification.

Basic Equations:

C = N * EFA / (GO * Ago * V * 1000)

S = EFA / (GO * Ago * V * 1000)

C = N * S

V = Flow * Time

EFA = effective filter area
GO = number of grid openings counted
Ago = area of one grid opening
V = volume of air passed through filter
S = analytical sensitivity = 1/volume analyzed

GOs needed to hit target S

GO = EFA / (S * Ago * V * 1000)

Note: to make GO small, must make V big

S	0.00004	cc-1
EFA	385	mm2
Ago	0.01	mm2
V	21600	L
GO	45	

Volume Calc

Flow	3	L/min
Time	5	days
V	21600	L

APPENDIX G

FIELD FORMS

TETRA TECH EM INC.
OU7 OUTDOOR AMBIENT AIR - FIELD SAMPLE DATA SHEET (FSDS)

Station Location: **T-4 (Troy Info Center)**
Field Technician: _____
Pump Type/Model: **SKC AirChek 2000**
Pump Number: _____

Sample ID #: **TA-**
Filter ID #: _____
Sample Type: _____
Sample Parent ID #: _____

START DAY

Date: _____
Time: _____

Timer Beginning Time: _____
Beginning Flow Rate (L/min): _____
Atmospheric pressure (mm Hg): _____
Temperature inside station unit (^{o}F): _____

STOP DAY

Date: _____
Time: _____

Timer Ending Time: _____
Ending Flow Rate (L/min): _____
Total Sample Volume (L): _____
Total Sample Time (min): _____
Atmospheric pressure (mm Hg): _____
Temperature inside station unit (^{o}F): _____

DAILY CHECK (complete separate DAILY CHECK for each station visit - additional records on back)

(Field Tech Initials)

Date: _____ ( )
Time: _____ ( )

PUMP FAULT (Yes / No): _____
Timer Time (min): _____
Flow Rate (L/min): _____
Cumulative Sample Volume (L): _____
Cumulative Sample Time (min): _____
Atmospheric pressure (mm Hg): _____
Temperature inside station unit (^{o}F): _____
Battery voltage reading (volts): _____

COMMENTS: (Please note all photographs taken, major storm events, vandalism, and reason for pump fault)

SIGNATURE: **DATE:**

TETRA TECH EM INC.
OU7 OUTDOOR AMBIENT AIR - FIELD SAMPLE DATA SHEET (FSDS)
ADDITIONAL DAILY CHECK RECORDS

Station Location: **T-4 (Troy Info Center)**
Sample ID #: **TA-**
Field Technician:
Filter ID #:
Pump Type/Model: **SKC AirChek 2000**
Pump Number:

DAILY CHECK (For each station visit)

(Field Tech Initials)

Date: ( )
Time: ( )

PUMP FAULT (Yes / No):
Timer Time (min):
Flow Rate (L/min):
Cumulative Sample Volume (L):
Cumulative Sample Time (min):
Atmospheric pressure (mm Hg):
Temperature inside station unit (^{o}F):
Battery voltage reading (volts):

DAILY CHECK (For each station visit)

(Field Tech Initials)

Date: ( )
Time: ( )

PUMP FAULT (Yes / No):
Timer Time (min):
Flow Rate (L/min):
Cumulative Sample Volume (L):
Cumulative Sample Time (min):
Atmospheric pressure (mm Hg):
Temperature inside station unit (^{o}F):
Battery voltage reading (volts):

DAILY CHECK (For each station visit)

(Field Tech Initials)

Date: ( )
Time: ( )

PUMP FAULT (Yes / No):
Timer Time (min):
Flow Rate (L/min):
Cumulative Sample Volume (L):
Cumulative Sample Time (min):
Atmospheric pressure (mm Hg):
Temperature inside station unit (^{o}F):
Battery voltage reading (volts):

DAILY CHECK (For each station visit)

(Field Tech Initials)

Date: ( )
Time: ( )

PUMP FAULT (Yes / No):
Timer Time (min):
Flow Rate (L/min):
Cumulative Sample Volume (L):
Cumulative Sample Time (min):
Atmospheric pressure (mm Hg):
Temperature inside station unit (^{o}F):
Battery voltage reading (volts):

DAILY CHECK (For each station visit)

(Field Tech Initials)

Date: ( )
Time: ( )

PUMP FAULT (Yes / No):
Timer Time (min):
Flow Rate (L/min):
Cumulative Sample Volume (L):
Cumulative Sample Time (min):
Atmospheric pressure (mm Hg):
Temperature inside station unit (^{o}F):
Battery voltage reading (volts):

APPENDIX H

TETRA TECH FIELD AUDIT CHECKLIST

TETRA TECH, INC.

FIELD AUDIT CHECKLIST

Project Name: _____ Project No.: _____

Field Location: _____ Completed by: _____

Project Manager: _____ Site Safety Coordinator: _____

General Items		In Compliance?		
Health and Safety Plan Requirements		Yes	No	NA
1	Approved health and safety plan (HASP) on site or available			
2	Names of on-site personnel recorded in field logbook or daily log			
3	HASP compliance agreement form signed by all on-site personnel			
4	Material Safety Data Sheets on site or available			
5	Designated site safety coordinator present			
6	Daily tailgate safety meetings conducted and documented			
7	On-site personnel meet HASP requirements for medical examinations, fit testing, and training (including subcontractors)			
8	Compliance with specified safe work practices			
9	Documentation of training, medical examinations, and fit tests available from employer			
Emergency Planning				
13	Emergency telephone numbers posted			
14	Emergency route to hospital posted			
15	Local emergency providers notified of site activities			
16	Adequate safety equipment inventory available			
17	First aid provider and supplies available			
Air Monitoring				
19	Monitoring equipment specified in HASP available and in working order			
20	Monitoring equipment calibrated and calibration records available			
21	Personnel know how to operate monitoring equipment and equipment manuals available on site			
23	Environmental and personnel monitoring performed as specified in HASP			

TETRA TECH, INC.

FIELD AUDIT CHECKLIST (Continued)

Safety Items		In Compliance?		
Personal Protection		Yes	No	NA
1 Tivek Suit				
2 Protective clothing				
3	Safety glasses or goggles			
4 Gloves				
5 Overboots				
6 Respirator				
Field Documentation				
10	FSDSs are completed correctly			
11	Pump and MET station data are downloaded			
Supplies				
13	Decontamination equipment and supplies			
14 Fire extinguishers				
15	Mobile Phone			
Corrective Action Taken During Audit:				
Corrective Action Still Needed:				

Note: NA = Not applicable

_____ _____

Auditor's Signature Site Safety Coordinator's Signature

_____

Date

APPENDIX I

TROY RECORD OF MODIFICATION FORM

Record of Modification

to the
OU7 Remedial Investigation Work Plan
Outdoor Ambient Air Study
TFO-__ __ __ __ __ (numbered by Data Manager)

Instructions to Requester: **Fax to contacts at bottom of form for review and approval.**
File approved copy with Data Manager at the Troy Field Office (TFO).
Data Manager will maintain legible copies in a binder that can be accessed by TFO personnel.
If Modification is Temporary for a Single Parcel, Data Manager will scan this and place in parcel's electronic file.

Project Work Plan/QAPP (check one)**:**

- o Outdoor Ambient Air Study Work Plan
- o Other (Title and approval date):_____

Site-Specific Guidance/SOP:

Title_____ Number/Revision): _____

Requester: _____ Title: _____
Company: _____ Date: _____

Description of Modification (attach additional sheets if necessary; state section and page numbers of each document that are affected by the proposed modification):_____
_____
_____

Field Sampling Data Sheet where Modification is documented (attach associated correspondence):
_____

Potential Implications of Modification: _____
_____
_____

Duration of Modification (check one):

- o Temporary
  Date(s):_____ Station Number-_____
  TA-_____
- o Permanent (Proposed Text Modification Section) Effective Date:_____

Proposed Text Modifications in Associated Document (attach additional sheets if necessary):_____
_____
_____

Data Quality Indicator (circle one) – Please reference definitions on reverse side for direction on selecting data quality indicators:

Not Applicable **Reject** **Low Bias** **Estimate** **High Bias** **No Bias**

Technical Review and Approval: _____ Date:_____
(DEQ Project Manager or designate)

EPA Review and Approval: _____ Date:_____
(*USEPA RPM or designate*)

Revised April 29, 2007

DATA QUALITY INDICATOR DEFINITIONS

Reject - Samples associated with this modification form are not useable. The conditions outlined in the modification form adversely effect the associated sample to such a degree that the data are not reliable.

Low Bias - Samples associated with this modification form are useable, but results are likely to be biased low. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimated low.

Estimate - Samples associated with this modification form are useable, but results should be considered approximations. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimates.

High Bias - Samples associated with this modification form are useable, but results are likely to be biased high. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimated high.

No Bias - Samples associated with this modification form are useable as reported. The conditions outlined in the modification form suggest that associated sample data are reliable as reported.

APPENDIX J

EPA DATA REPORTING REQUIREMENTS FOR THE LIBBY ASBESTOS SUPERFUND SITE (VERSION 10)

Official Source	Sort Order	Required?	Scribe Field Name	Description	Data Type	Value Values?	Value Values Description
LibbyWebsite	1	Yes	n/a	EPA-generated identifier that is associated with a specific document. Serves as the Primary Key for the EPA reporting table named "DocumentMetadata".	Text (50)	Yes (PK)	Must be unique within the Document table.
LibbyWebsite	2	No	n/a	The name of the EPA reporting table that this document is associated with.	Text (50)	Yes	See list of Valid Values.
LibbyWebsite	3	No	n/a	The value of the Primary Key for the EPA reporting table that this document is associated with.	Text (50)	Yes	Value must exist in the primary key field of the associated table.
LibbyWebsite	4	Yes	n/a	Date that the document was created. If an electronic document was generated from a hard copy, use the date the hard copy was created.	Date/Time	No	none
LibbyWebsite	5	Yes	n/a	Category that best describes the document or electronic file.	Text (50)	Yes	See list of Valid Values.
LibbyWebsite	6	Yes	n/a	Subtype that best describes the document or electronic file.	Text (50)	Yes	See list of Valid Values.
LibbyWebsite	7	No	n/a	Comments pertaining to the document.	Text (250)	No	none
LibbyGeo	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
LibbyGeo	2	Yes	same	EPA-generated identifier for a specific property that all tabular data is to be associated with. Serves as the Primary Key for the table named PropertyInfo.	Text (50)	Yes (PK)	Must be unique.
LibbyGeo	3	No	same	Description for landmark properties	Text (100)	No	none
LibbyGeo	4	No	same	Name of the business that is associated with this property.	Text (50)	No	none
LibbyGeo	5	No	same	Street number of property	Text (20)	No	none
LibbyGeo	6	No	same	Prefix direction of property street	Text (2)	Yes	E,W,N,S,NW,NE,SW,SE
LibbyGeo	7	No	PropertyAddress	Physical street address for a specific property.	Text (150)	No	none
LibbyGeo	8	No	same	Suffix direction of property street	Text (2)	Yes	E,W,N,S,NW,NE,SW,SE
LibbyGeo	9	No	PropertyAddress2	Apartment number for a specific property.	Text (50)	No	none
LibbyGeo	10	No	same	City associated with a specific property.	Text (50)	No	none
LibbyGeo	11	No	PropertyZone	Operable Unit associated with a specific property.	Text(25)	Yes	OU1,OU2,OU3,OU4,OU5,OU6,OU7,OU8,None
LibbyGeo	12	No	same	Comments pertaining to this property.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	EPA-generated identifier for a specific property that all tabular data is to be associated with. Serves as the Foreign Key to the EPA reporting table named "PropertyInfo".	Text (50)	Yes (FK)	Must exist in the Property table.
Scribe	3	Yes	same	Unique identifier for a value that is associated with a specific status descriptor for a property. Serves as the Primary Key for the EPA reporting table named "PropertyStatus".	Text (50)	Yes (PK)	Must be unique within the PropertyStatus table.
Scribe	4	Yes	same	Descriptor or attribute that is to be used to describe a property's status.	Text (50)	Yes	See list of Valid Values.
Scribe	5	Yes	same	Beginning date associated with this attribute's association with a property.	Date/Time	No	none
Scribe	6	No	same	Last date associated with this attribute's association with a property.	Date/Time	No	none
Scribe	7	No	same	Comments pertaining to this descriptors's association with a property.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	EPA-generated identifier for a specific property that all tabular data is to be associated with. Serves as the Foreign Key to the EPA reporting table named "PropertyInfo".	Text (50)	Yes (FK)	Must exist in the Property table.
Scribe	3	Yes	same	The contact information for this communication. Serves as the Foreign Key to the EPA reporting table named "Contact".	Text (50)	Yes (FK)	Must exist in the Contact table.
Scribe	4	Yes	same	Unique identifier for a property contact. Serves as the Primary Key for the EPA reporting table named "PropertyContact".	Text (50)	Yes (PK)	Must be unique within the PropertyContact table.
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Unique identifier for a contact. Serves as the Primary Key to the EPA reporting table named "Contact".	Text (50)	Yes (PK)	Must be unique within the Contact table.
Scribe	3	Yes	same	Type of contact.	Text (50)	Yes	See list of Valid Values.
Scribe	4	Yes	same	First name of contact.	Text (50)	No	none
Scribe	5	Yes	same	Last name of contact.	Text (50)	No	none
Scribe	6	No	same	Name of the business that is associated with this contact.	Text (50)	No	none
Scribe	7	No	same	Street address (including apartment number) associated with contact's mailing address.	Text (50)	No	none
Scribe	8	No	same	City associated with contact's mailing address.	Text (50)	No	none
Scribe	9	No	same	2-character state postal abbreviation associated with contact's mailing address.	Text (2)	Yes	See list of Valid Values.
Scribe	10	No	same	Zip code associated with contact's mailing address.	Text (10)	No	none
Scribe	11	No	same	Primary phone number for contact in the format ###-###-####.	Text (20)	No	none
Scribe	12	No	same	Alternate phone number for contact in the format ###-###-####.	Text (20)	No	none
Scribe	13	No	same	Email address for contact.	Text (50)	No	none
Scribe	14	No	same	Comments pertaining the contact information.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	No	same	EPA-generated identifier for a specific property that all tabular data is to be associated with. Serves as the Foreign Key to the EPA reporting table named "PropertyInfo".	Text (50)	Yes (FK)	Must exist in the Property table.
Scribe	3	Yes	same	The contact information for this communication. Serves as the Foreign Key to the EPA reporting table named "Contact".	Text (50)	Yes (FK)	Must exist in the Contact table.
Scribe	4	Yes	same	Unique identifier for a communication record. Serves as the Primary Key for the EPA reporting table named "Communication".	Text (50)	Yes (PK)	Must be unique within the Communication table.
Scribe	5	Yes	same	Date of initial communication.	Date/Time	No	none
Scribe	6	Yes	same	Category that best describes the communication.	Text (50)	Yes	See list of Valid Values.
Scribe	7	Yes	same	Description of the communication, the action that is required and any comments related to the resolution of this	Memo	No	none
Scribe	8	Yes	same	Current status of communication.	Text (50)	Yes	See list of Valid Values.
Scribe	9	Yes	same	Date that the communication status was last updated.	Date/Time	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Identifier for a specific data collection effort. Serves as the Primary Key for the EPA reporting table "Event".	Text (50)	Yes (PK)	Must be unique within the Event table.
Scribe	3	Yes	same	Beginning date associated with this event.	Date/Time	No	none
Scribe	4	No	same	Last date associated with this event.	Date/Time	No	none
Scribe	5	No	same	Comments pertaining to a specific data collection effort.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	EPA-generated identifier for a specific property that all tabular data is to be associated with. Serves as the Foreign Key to the EPA reporting table named "PropertyInfo".	Text (50)	Yes (FK)	Must exist in the Property table.
Scribe	3	Yes	Location	Identifier for a point, area or structure where data is collected. Serves as the Primary Key for the EPA reporting table named "Location".	Text (30)	Yes (PK)	Must be unique within the Location table.
Scribe	4	Yes	same	Type that describes the location.	Text (50)	Yes	See list of Valid Values.
Scribe	5	No	same	Area of the location in square feet (applies to building or use area).	Numeric	No	none
Scribe	6	Conditional	Latitude	The geographically corrected GPS measurement for a location's latitude in decimal degrees. Required if Location Longitude is not null.	Numeric	No	none

Official Source	Sort Order	Required?	Scribe Field Name	Description	Data Type	Value Values?	Value Values Description
Scribe	7	Conditional	Longitude	The geographically corrected GPS measurement for a location's longitude in decimal degrees. Required if Location Latitude is not null.	Numeric	No	none
Scribe	8	Conditional	Datum	Datum associated with the latitude and longitude measurements. Required if Location Latitude and Location Longitude are not null.	Text (10)	Yes	See list of Valid Values.
Scribe	9	No	same	Comments pertaining to the location.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Identifier for a set of data collection parameters or characteristics. Serves as the Primary Key for the EPA reporting table named "Survey".	Text (50)	Yes (PK)	Must be unique within the Survey table.
Scribe	3	No	same	Version associated with this survey	Text (3)	No	none
Scribe	4	Yes	same	Date that this version of the survey was first used.	Date/Time	No	none
Scribe	5	No	same	Date that this version of the survey was last used.	Date/Time	No	none
Scribe	6	No	same	Comments pertaining to the survey.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Identifier for a set of data collection parameters or characteristics. Serves as the Foreign Key to the Survey table.	Text (50)	Yes (FK)	Must exist in the Survey table.
Scribe	3	Yes	same	Identifier for a data collection parameters or characteristics that is part of a survey. Serves as the Primary Key for the Survey Parameter table.	Text (50)	No	Must be unique within the SurveyParameter table.
Scribe	4	Yes	same	SQL server data type associated with this Survey Parameter.	Text (50)	Yes	See list of Valid Values.
Scribe	5	No	same	Comments pertaining to survey question	Text (255)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Identifier for a data collection parameter or characteristic that is part of a survey. Serves as the Foreign Key to the EPA reporting table named "Survey Parameter".	Text (50)	Yes (FK)	Must exist in SurveyQuestion table.
Scribe	3	Yes	same	Identifier for a possible value that is associated with a data collection parameter or characteristic. Serves as the Primary Key for the EPA reporting table named "Survey Parameter".	Text (50)	Yes (PK)	Must be unique within the Survey Parameter Value table.
Scribe	4	Yes	same	Possible answer (valid value) associated with a specific survey question	Text (50)	No	none
Scribe	5	No	same	Comments pertaining to the parameter value.	Text (255)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Identifier for a data collection effort. Serves as the Foreign Key to the EPA reporting table named "Event".	Text (50)	Yes (FK)	Must exist in the Event table.
Scribe	3	Yes	same	EPA-generated identifier for a specific property that all tabular data is to be associated with. Serves as the Foreign Key to the EPA reporting table named "PropertyInfo".	Text (50)	Yes (FK)	Must exist in the Project table.
Scribe	4	No	Location	Identifier for a point, area or structure where data is collected. Serves as the Foreign Key to the EPA reporting table named "Location".	Text (30)	Yes (FK)	Must exist in the Location table.
Scribe	5	No	same	Unique identifier for a sample that is collected. Serves as the Foreign Key to the EPA reporting table named "Sample". Used to link a visible vermiculite survey to a sample.	Text (50)	Yes (FK)	Must exist in the Sample table.
Scribe	6	Yes	same	Identifier for a set of data collection parameters or characteristics. Serves as the Foreign Key to the EPA reporting table named "Survey".	Text (50)	Yes (FK)	Must exist in the Survey table.
Scribe	7	Yes	same	Identifier for a data collection parameter or characteristic that is part of a specific survey. Serves as the Foreign Key to the EPA reporting table named "Survey Parameter".	Text (50)	Yes (FK)	Must exist in the Survey Parameter table.
Scribe	8	Conditional	same	Identifier for a valid value associated with a survey's specific data collection parameter or characteristic. Serves as the Foreign Key to the EPA reporting table named "Survey Parameter Value". Required if Survey Result Text is null.	Text (50)	Yes (FK)	Must exist in the Survey Parameter Value table.
Scribe	9	Yes	same	Unique identifier for a response that is associated with a specific data collection parameter or characteristic within a survey. Serves as the Primary Key for the EPA reporting table named "Survey Result".	Text (50)	Yes (PK)	Must be unique within the Survey Result table.
Scribe	10	Conditional	same	Free text response associated with a survey parameter. Required if Survey Parameter Value ID is null.	Text (50)	No	none
Scribe	11	Yes	same	Date that the survey result was obtained (beginning date if the result was obtained over a range of dates).	Date/Time	No	none
Scribe	12	No	same	End date that the survey result was obtained if the result was obtained over a range of dates.	Date/Time	No	none
Scribe	13	No	same	Comments pertaining to survey result.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Identifier for a specific data collection effort. Serves as the Foreign Key to the EPA reporting table named "Event".	Text (50)	Yes (FK)	Must exist in the Event table.
Scribe	3	Yes	Location	Identifier for a point, area or structure where data is collected. Serves as the Foreign Key to the EPA reporting table named "Location".	Text (50)	Yes (FK)	Must exist in the Location table.
Scribe	4	Yes	Samp_No	Unique identifier for a sample that is collected. Serves as the Primary Key for the EPA reporting table named "Sample".	Text (50)	Yes (PK)	Must be unique within the Sample table.
Scribe	5	No	Sub_Location	Detailed description of point within the location that a sample was taken (for example: shoulder, living room window sill, downstairs closet, play area).	Text (100)	No	none
Scribe	6	Yes	same	Type of sample that is collected.	Text (50)	Yes	See list of Valid Values.
Scribe	7	Conditional	same	Parent sample ID for this sample. Required if Sample Type is Field Duplicate, Field Replicate or Field Split. Serves as the Foreign Key to the EPA reporting table named "Sample".	Text (50)	Yes	Must exist within the Sample table.
Scribe	8	Yes	same	Indication whether or not the sample is a composite sample.	Text (3)	Yes	See list of Valid Values.
Scribe	9	Conditional	same	The number of subsamples that make up a composite sample. Required if Sample Composite YN is Yes.	Number	No	none
Scribe	10	Yes	Matrix	Description of the media that is sampled.	Text (40)	Yes	See list of Valid Values.
Scribe	11	Conditional	same	Description of the sub-media that is sampled.	Text (50)	Yes	See list of Valid Values.
Scribe	12	Conditional	same	Pore size of filter used during sample collection (microns)	Numeric	Yes	See list of Valid Values.
Scribe	13	Conditional	same	Diameter of filter used during sample collection (mm)	Numeric	Yes	See list of Valid Values.
Scribe	14	Yes	same	Begin date of total sampling period for this sample	Date/Time	No	none
Scribe	15	No	same	Begin time of total sampling period for this sample	Date/Time	No	none
Scribe	16	No	same	End date of total sampling period for this sample	Date/Time	No	none
Scribe	17	No	same	End time of total sampling period for this sample	Date/Time	No	none
Scribe	18	Conditional	Sample_Depth	Top of depth where sample is collected (0 for surface) in relation to ground surface (as opposed to excavation surface). Required if Sample Matrix is Soil.	Numeric	No	none
Scribe	19	Conditional	Sample_Depth_To	Bottom of depth where sample is collected in relation to ground surface (as opposed to excavation surface). Required if Sample Matrix is Soil.	Numeric	No	none
Scribe	20	Conditional	Sample_Depth_Units	Units of measurement for depths where sample is collected. Required if Sample Matrix is Soil.	Text (50)	Yes	See list of Valid Values.
Scribe	21	Conditional	same	Area of sample that is collected. Required if Sample Matrix is Dust.	Numeric	No	none
Scribe	22	Conditional	same	Units of measure for SampleArea. Required if Sample Matrix is Dust.	Text (50)	Yes	See list of Valid Values.
Scribe	23	Conditional	Volume	Volume of sample that is collected. Required if Sample Matrix is Air.	Numeric	No	none
Scribe	24	Conditional	Volume_Units	Units of measure for SampleArea. Required if Sample Volume is not null.	Text (20)	Yes	See list of Valid Values.

Official Source	Sort Order	Required?	Scribe Field Name	Description	Data Type	Value Values?	Value Values Description
Scribe	25	No	same	Description of sampling scenario (e.g. Sampling during routine household activities). For use during activity based sampling activities.	Text (100)	No	none
Scribe	26	Conditional	same	Task being performed while personal air sample is collected. Required if Sample Matrix is Air and Sample SubMatrix is Personal.	Text (50)	No	none
Scribe	27	Conditional	same	Type of activity being performed while personal air sample is collected. Required if Sample Type is Air and Sample SubMatrix is Personal.	Text (50)	No	none
Scribe	28	No	same	Indicates if this is a Pre, Post, or Clearance sampling activity as opposed to a regular sampling activity.	Text (50)	Yes	See list of Valid Values.
Scribe	29	No	same	Page, field book number, etc referring to field notes of sample	Text (50)	No	none
Scribe	30	No	Remarks	Comments pertaining to the sample that is collected.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Unique identifier for the information related to the drying of a sample that is being recorded. Serves as the Primary Key for the Drying Log table.	Numeric	Yes (PK)	Must be unique within the Drying Log table.
Scribe	3	Yes	Samp_No	Identifier for a sample that is collected. Serves as the Foreign Key to the Sample table.	Text (50)	Yes (FK)	Must exist in the Sample table.
Scribe	4	Yes	same	Identifier for the group of samples that is dried together in one batch.	Text (50)	No	none
Scribe	5	Yes	same	Date that the sample was dried (use the start date if the sample was dried over a range of days).	Date/Time	No	none
Scribe	6	Yes	same	Calculated dry weight of the sample after drying in grams.	Numeric	No	none
Scribe	7	No	same	Comments pertaining to the information related to the drying of a sample that is being recorded.	Text (250)	No	none
Scribe	1	Yes	Site_No	Should always be "08BC".	Text (12)	Yes	"08BC"
Scribe	2	Yes	same	Unique identifier for the information related to the grinding of a sample that is being recorded. Serves as the Primary Key for the Grinding Log table.	Numeric	Yes (PK)	Must be unique within the Grinding Log table.
Scribe	3	Yes	Samp_No	Identifier for a sample that is collected. Serves as the Foreign Key to the Sample table.	Text (50)	Yes (FK)	Must exist in the Sample table.
Scribe	4	Yes	same	Identifier for the group of samples that is ground together in one batch.	Text (50)	No	none
Scribe	5	Yes	same	Date that the sample was ground (use the start date if the sample was ground over a range of days).	Date/Time	No	none
Scribe	6	Yes	same	Suffix to the SampleID indicating whether the sample was a fine or coarse ground fraction. Used for the PLM methods. (9002, Grav, VE)	Text (50)	Yes	See list of Valid Values.
Scribe	7	Yes	same	Calculated weight of the subsample after grinding and sieving in grams.	Numeric	No	none
Scribe	8	No	same	Identifier for a Prep Lab sample that indicates if the sample was a Prep Lab Blank or a Prep Lab Duplicate.	Text (50)	Yes	See list of Valid Values.
Scribe	9	No	same	Identifier for a Prep Lab sample that indicates if the sample was a Prep Lab Oven Blank or a Prep Lab Grinder Blank.	Text (50)	Yes	See list of Valid Values.
Scribe	10	No	same	Identifier for a sample that was duplicated in the Prep Lab. SampleID links back to the original field sample in the Sample Table.	Text (50)	Yes (FK)	Must exist in the Sample table.
Scribe	11	No	same	Comments pertaining to the information related to the grinding of a sample that is being recorded.	Text (250)	No	none

Table Name	FieldName	Value Values Description	Qualifier Field Name	Qualifier Value	Comments
Document	DocumentAssociatedTable	PropertyInfo			
Document	DocumentAssociatedTable	PropertyStatus			
Document	DocumentAssociatedTable	Contact			
Document	DocumentAssociatedTable	Communication			
Document	DocumentAssociatedTable	Events			
Document	DocumentAssociatedTable	Location			
Document	DocumentAssociatedTable	Survey			
Document	DocumentAssociatedTable	SurveyParameter			
Document	DocumentAssociatedTable	SurveyParameterValue			
Document	DocumentAssociatedTable	SurveyResult			
Document	DocumentAssociatedTable	Samples			
Document	DocumentAssociatedTable	DryingLog			
Document	DocumentAssociatedTable	GrindingLog			
Document	DocumentCategory	Paper			
Document	DocumentCategory	Electronic			
Document	DocumentCategory	CAD			
Document	DocumentType	Pre-design Inspection Survey			
Document	DocumentType	Results Mailing (ABS)			To include cover letter, results and explanation of results.
Document	DocumentType	Results Mailing (2005 Soils)			
Document	DocumentType	Thank You Letter (ABS)			
Document	DocumentType	Access Refusal Letter to Resident			
Document	DocumentType	Access Agreement (ABS)			
Document	DocumentType	Access Agreement (Inspection)			
Document	DocumentType	Access Agreement (Removal)			
Document	DocumentType	HEPA Vac Receipt Form			
Document	DocumentType	Property Status Mailing (2007)			
Document	DocumentType	Comfort Letter			
Document	DocumentType	Authorization for Temporary Relocation Assistance (Business)			
Document	DocumentType	Authorization for Temporary Relocation Assistance (Residential)			
Document	DocumentType	Background Information Field Form (BIFF)			
Document	DocumentType	Removal Relocation (Business Questionnaire)			
Document	DocumentType	Laboratory Data Package			
Document	DocumentType	ERS Hotline Notification			
Document	DocumentType	Existing Conditions Letter			
Document	DocumentType	Field Modification Form			
Document	DocumentType	Chain of Custody (Field Team)			
Document	DocumentType	Removal Relocation (Government Housing Waiver)			
Document	DocumentType	Removal Relocation (Hotel Form)			
Document	DocumentType	Removal (Important Reminders Flier)			
Document	DocumentType	ERS Initial Assessment Checklist			
Document	DocumentType	Laboratory Modification Forms			
Document	DocumentType	RAWP (Landscape Inventory)			
Document	DocumentType	RAWP (Landscape Inventory Revision)			
Document	DocumentType	Inspection (Miscellaneous Notes)			
Document	DocumentType	Analytical Summary Sheets			
Document	DocumentType	Field Logbook			
Document	DocumentType	Removal Relocation (Notes from Review and Relocation Meeting)			
Document	DocumentType	RAWP (Owner Request to Change Work Plan)			
Document	DocumentType	Inspection (Point of Contact Form)			
Document	DocumentType	Removal Relocation (Pre-payment Voucher Form)			
Document	DocumentType	Removal (Property Condition Assesssment)			
Document	DocumentType	Property Inspection Report			

Table Name	FieldName	Value Values Description	Qualifier Field Name	Qualifier Value	Comments
Document	DocumentType	Property Inspection Sketch			
Document	DocumentType	ERS Quick Response Statement of Work			
Document	DocumentType	Record of Communication			
Document	DocumentType	Removal Relocation (Reimbursement Claim for Temporary Relocation Assistance)			
Document	DocumentType	Removal and Restoration Completion Form			
Document	DocumentType	Removal and Restoration Inspection Checklist			
Document	DocumentType	Removal Completion Letter			
Document	DocumentType	Removal Relocation (Request and Authorization for Direct Deposit)			
Document	DocumentType	Removal Relocation (Request and Receipt of Pre-Payment)			
Document	DocumentType	Chain of Custody (Sample Preparation Facility)			
Document	DocumentType	Sample Preparation Modification Form)			
Document	DocumentType	ABS Sampling Participant Activity Log)			
Document	DocumentType	RAWP (Signed Addendum)			
Document	DocumentType	RAWP (Signed Addendum Ammendment)			
Document	DocumentType	RAWP (Signed Addendum Modification)			
Document	DocumentType	RAWP (Signed Attic Floor and Exterior Restoration Details)			
Document	DocumentType	RAWP (Signed Plan Notes and Legend)			
Document	DocumentType	RAWP (Signed Remediation Plan)			
Document	DocumentType	RAWP (Signed Restoration Plan)			
Document	DocumentType	Visible Vermiculite Re-Inspection Form			
Document	DocumentType	Removal Relocation (Water Reimbursement Acknowledgement Form)			
Document	DocumentType	Removal Relocation (Water Reimbursement Voucher)			
Property	PropertyState	ID			
Property	PropertyState	MT			
Property	PropertyState	WA			
PropertyStatus	PropertyStatus	Access Agreement Signed (ABS)			
PropertyStatus	PropertyStatus	Access Agreement Unsigned (ABS)			
PropertyStatus	PropertyStatus	Access Agreement Signed (Inspection)			
PropertyStatus	PropertyStatus	Access Agreement Unsigned (Inspection)			
PropertyStatus	PropertyStatus	Access Agreement Signed (Removal)			
PropertyStatus	PropertyStatus	Access Agreement Unsigned (Removal)			
PropertyStatus	PropertyStatus	Inspection Refused (CSS)			
PropertyStatus	PropertyStatus	Inspection Pending (CSS)			
PropertyStatus	PropertyStatus	Inspection Complete (CSS)			
PropertyStatus	PropertyStatus	Inspection Refused (TAPE)			
PropertyStatus	PropertyStatus	Inspection Pending (TAPE)			
PropertyStatus	PropertyStatus	Inspection Complete (TAPE)			
PropertyStatus	PropertyStatus	Pre-Design Refused			
PropertyStatus	PropertyStatus	Pre-Design Pending			
PropertyStatus	PropertyStatus	Pre-Design Complete			
PropertyStatus	PropertyStatus	Removal Refused			
PropertyStatus	PropertyStatus	Removal Pending			
PropertyStatus	PropertyStatus	Removal Complete			
Contact	ContactType	Financial Institution			
Contact	ContactType	Owner			
Contact	ContactType	Former Owner			
Contact	ContactType	Property Representative			
Contact	ContactType	Tenant			
Contact	ContactType	Unknown			
Contact	ContactMailingState	AL			
Contact	ContactMailingState	AR			
Contact	ContactMailingState	AZ			

Table Name	FieldName	Value Values Description	Qualifier Field Name	Qualifier Value	Comments
Contact	ContactMailingState	CA			
Contact	ContactMailingState	CO			
Contact	ContactMailingState	CT			
Contact	ContactMailingState	DE			
Contact	ContactMailingState	FL			
Contact	ContactMailingState	GA			
Contact	ContactMailingState	HI			
Contact	ContactMailingState	IA			
Contact	ContactMailingState	ID			
Contact	ContactMailingState	IL			
Contact	ContactMailingState	IN			
Contact	ContactMailingState	KS			
Contact	ContactMailingState	KY			
Contact	ContactMailingState	LA			
Contact	ContactMailingState	MA			
Contact	ContactMailingState	MD			
Contact	ContactMailingState	ME			
Contact	ContactMailingState	MI			
Contact	ContactMailingState	MN			
Contact	ContactMailingState	MO			
Contact	ContactMailingState	MS			
Contact	ContactMailingState	MT			
Contact	ContactMailingState	NC			
Contact	ContactMailingState	ND			
Contact	ContactMailingState	NE			
Contact	ContactMailingState	NH			
Contact	ContactMailingState	NJ			
Contact	ContactMailingState	NM			
Contact	ContactMailingState	NV			
Contact	ContactMailingState	NY			
Contact	ContactMailingState	OH			
Contact	ContactMailingState	OK			
Contact	ContactMailingState	OR			
Contact	ContactMailingState	PA			
Contact	ContactMailingState	RI			
Contact	ContactMailingState	SC			
Contact	ContactMailingState	SD			
Contact	ContactMailingState	TN			
Contact	ContactMailingState	TX			
Contact	ContactMailingState	UT			
Contact	ContactMailingState	VA			
Contact	ContactMailingState	VT			
Contact	ContactMailingState	WA			
Contact	ContactMailingState	WI			
Contact	ContactMailingState	WV			
Contact	ContactMailingState	WY			
Communication	CommunicationType	Email			
Communication	CommunicationType	Office Visit			
Communication	CommunicationType	Phone Call			
Communication	CommunicationType	Mailing			
Location	LocationType	Sampling Point			
Location	LocationType	House			

Table Name	FieldName	Value Values Description	Qualifier Field Name	Qualifier Value	Comments
Location	LocationType	Shed			
Location	LocationType	Specific Use Area			
Location	LocationType	Common Use Area			
Location	LocationType	Limited Use Area			
Location	LocationType	Non Use Area			
Location	LocationLat/LongDatum	NAD83			
Sample	SampleType	Field Blank			
Sample	SampleType	Field Duplicate			
Sample	SampleType	Field Replicate			
Sample	SampleType	Field Sample			
Sample	SampleType	Field Split			
Sample	SampleType	Lab Blank			
Sample	SampleType	Lab Duplicate			
Sample	SampleType	Lot Blank			
Sample	SampleCompositeYN	Yes			
Sample	SampleCompositeYN	No			
Sample	SampleMatrix	Air			
Sample	SampleMatrix	Dust			
Sample	SampleMatrix	Sediment			
Sample	SampleMatrix	Soil			
Sample	SampleMatrix	Water			
Sample	SampleSubMatrix	Personal (30min Excursion)	Sample Matrix	Air	
Sample	SampleSubMatrix	Personal (8hr Time Weighted Average)	Sample Matrix	Air	
Sample	SampleSubMatrix	Stationary	Sample Matrix	Air	
Sample	SampleDepthUnit	in			
Sample	SampleAreaUnit	cm2			
Sample	SamplePrePostClear	Pre			
Sample	SamplePrePostClear	Post			
Sample	SamplePrePostClear	1st Clear			
Sample	SamplePrePostClear	2nd Clear			
Sample	SamplePrePostClear	3rd Clear			
Sample	SamplePrePostClear	4th Clear			
Sample	SamplePrePostClear	5th Clear			
Sample	SamplePrePostClear	6th Clear			
Sample	SamplePrePostClear	7th Clear			
Sample	SampleFilterDiameter	25			
Sample	SampleFilterDiameter	37			
Sample	SampleFilterPoreSize	0.45	Analytical Procedure	TEM	
Sample	SampleFilterPoreSize	0.8	Analytical Procedure	PCM	
Sample	SampleVolumeUnit	Liters			
Grinding Log	GrindingSubsampleTag	A			
Grinding Log	GrindingSubsampleTag	C			
Grinding Log	GrindingSubsampleTag	FG1			
Grinding Log	GrindingSubsampleTag	FG2			
Grinding Log	GrindingSubsampleTag	FG3			
Grinding Log	GrindingSubsampleTag	FG4			