PROPOSAL FOR

ATTRIBUTION OF HAZE PROJECT

Prepared For

Western Governors' Association
Western Regional Air Partnership
1515 Cleveland Place, Suite 200
Denver, CO 80202

Bid Number 04WGA134WRAP

Prepared by

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525

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1.0 INTRODUCTION

The Western Regional Air Partnership (WRAP) is comprised of representatives from cooperating western states, tribes, and federal agencies. The WRAP was primarily established to implement the recommendation of the Grand Canyon Visibility Transport Commission (GCVTC) and to develop technical and policy tools to assist western states and tribes comply with the U.S. Environmental Protection Agency's (EPA) Regional Haze Rule (RHR). WRAP carries out its responsibilities through a network of committees and forums.

The WRAP Technical Oversight Committee established a work group to oversee the 2004 Attribution of Haze (AoH) project. The overall objective of the project is to prepare a policy-level report (by January 2005) describing the emission source categories and geographic source regions presently contributing to visibility impairment, at each of the over 100 federal and tribal Class I areas in the WRAP region. Accomplishing this objective will require a coordinated effort among the AoH Workgroup, the selected AoH contractor, WRAP staff, cooperating scientists and policy experts, and other WRAP committees and workgroups.

This report will provide state and tribal air regulators with an initial detailed assessment of the geographic regions and source categories affecting the Class I areas for which they are responsible. This report will be an integral part of the interactive process the WRAP will pursue toward providing regulators with the information and tools they need to meet the 2007 regional haze plan deadline.

The AoH Workgroup released request for proposal (RFP) 04WGA134WRAP to secure the assistance of a contractor to integrate and synthesize available information into a policy-level attribution of haze report. Air Resource Specialists, Inc. (ARS) has prepared a response to the RFP that combines a highly qualified and experienced staff with sound technical and fiscal management to meet and exceed all of the requirements of the RFP. ARS has over 20 years experience in supporting visibility related projects and has nationally recognized expertise in a broad range of visibility disciplines. From operating national monitoring networks; participating in special studies; supporting federal land management agencies, the EPA, states, tribes, and municipalities; and working closely with various regional planning organizations (RPOs), ARS has been a dedicated contributor to broadening the understanding of visual air quality science and policy.

The proposed ARS approach includes an experienced principal investigator, dedicated scientists, the ability to provide the highest quality internal review, and a cooperative spirit all focused toward working with the AoH and WRAP staff to successfully achieve the project's objectives.

This proposal is organized into eight (8) major sections and supporting appendices:

1.0 Introduction
2.0 Scope of Work
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Any questions regarding this proposal can be addressed to:

Joe Adlhoch – Principal Investigator
John Molenar – Vice President
E-mail: jadlhoch@air-resource.com
jmolenar@air-resource.com
Phone: 970-484-7941
Fax: 970-484-3423

Web site: www.air-resource.com
Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525

2.0 SCOPE OF WORK

The scope of work is organized into three primary tasks. The work required under each task is summarized in Table 2-1.

Table 2-1

Scope of Work by Task
Attribution of Haze Project

Task No.	Title	Description
1	Analysis	• Integrate and synthesize available 2002 monitoring, modeling, and emissions data to identify: - Geographic source areas of emissions that contribute to impairment at Class I areas in the WRAP region. - Mass and species distributions of emissions by source category in each geographic source area. - Amount of natural and anthropogenic emissions affecting, and the associated visibility impact at, each Class I area.
2	Review and Discussion	• Present the findings of Task 1 to the AoH Workgroup. • Work with the AoH Workgroup to refine the findings into clear, policy-relevant explanations of the causes of visibility impairment in each Class I area. • Throughout the review and discussion process ARS will: - Document the assumptions and methods used in the integrated analysis. - Assess the biases and uncertainties in the data. - Provide clear, concise, policy-level summaries of estimated areas and sources of impairment for each Class I area, including the uncertainty of the estimates.
3	Additional/ Related Tasks	To facilitate the project, enhance the exchange of information, and achieve the project goals, ARS will perform the following components: • Component 1 – Support, facilitate, and summarize AoH Workgroup (and other project participants') input from in-person meetings, conference calls, and correspondence. • Component 2 – Document AoH Workgroup schedule and methodology leading to a consensus, policy-oriented report. • Component 3 – Provide and support a AoH project Web page on the WRAP Web site. The Web page will be a primary media for developmental project information exchange, interim results, and the final report. • Component 4 – Review, process, format, and manage data analyses and reports from WRAP forums' contractors, data centers, and extramural projects. • Component 5 – Compile topics reports from independent experts selected by the AoH Workgroup. • Component 6 – Prepare and publish the AoH project report. The process will include outlines, drafts, and a final Attribution of Haze Report.

The detailed approach that ARS will apply to successfully perform each of these tasks is presented in Section 3.0 of this proposal. Throughout the project, ARS will maintain a close, cooperative working relationship with assigned WRAP staff, members of the AoH Workgroup, and other project participants. ARS will bring together integral results and information, identify additional needs, work with the AoH Workgroup to compile consensus policy-level summaries, and prepare an on-line and bound AoH project report that will incorporate gateway and individual Class I area components.

The proposed schedule and deliverable products are summarized in Section 4.0 of this proposal. Key technical personnel are introduced in Section 5.0. The corporate overview and related project experience are presented in Section 6.0, and Section 7.0 is the detailed cost proposal for this effort. Section 8.0 lists references indicated throughout the proposal.

3.0 TECHNICAL PROPOSAL

Air Resource Specialists, Inc. (ARS) is pleased to offer this technical proposal in response to the Western Regional Air Partnership (WRAP) request for proposal (RFP) for the Attribution of Haze Project, dated April 29, 2004. The approach ARS proposes to complete each of the tasks outlined in the RFP is detailed below.

3.1 TASK 1 - ANALYSIS

3.1.1 Overall Approach

The WRAP has begun, and in some cases is nearing completion of, several major projects designed to better understand haze at Class I areas (CIAs) in the western U.S. The purpose of the Attribution of Haze (AoH) project is to integrate results from these major projects to yield a policy-relevant report which can be used by state and tribal air regulators to fulfill requirements of the EPA's Regional Haze Rule (RHR).

For this task, ARS' approach will be to:

- Review results from monitoring, modeling, and emissions inventory work completed by WRAP.
- Determine what topics, if any, require additional input from independent experts.
- Integrate and synthesize monitoring, modeling, and emissions inventory findings to identify:
  - Geographic source areas of emissions. ARS proposes to use the sub-region designations identified in the WRAP Causes of Haze Assessment (COHA) as a useful starting point for analysis. The degree to which all CIAs in a sub-region are inter-related will aid in the discussion of uncertainty of specific sub-region conceptual models.
  - Mass and species distributions of emissions by source type. ARS will assess the results of source apportionment techniques performed by other WRAP contractors to understand how local and regional emissions affect species mass measured at each CIA. ARS may suggest alternate, but complementary, source apportionment techniques be performed by an independent expert if additional information is required.
  - The contribution of natural and anthropogenic emissions. ARS will review refinements to the EPA's guidelines for determining natural visibility conditions. This work will be supported in large part by ARS' synthesis or WRAP data analysis and emissions inventories, but may require additional input from independent experts.

The following subsections provide additional detail for each component of the proposed technical approach.

3.1.2 Geographic Source Areas of Emissions

The WRAP domain encompasses the states of Alaska, Arizona, California, Colorado, Idaho, Montana, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. WRAP also includes tribal lands within these states and Nevada. In all, over 100 federal and tribal Class I areas (CIAs) are in this region. Not all CIAs host IMPROVE monitoring sites. In fact, there are many instances of CIA clusters, regionally and geographically similar, represented by a single monitoring site. In the WRAP Causes of Haze Assessment (COHA), twenty-one (21) sub-regions have been identified, based on a variety of factors including geography, meteorology, and emission source types. ARS will use these classifications as a useful starting point for analysis.

The COHA has answered a series of specific questions for each Class I area (COHA, 2004). Of particular interest to this analysis are answers to questions 1c and 1d, which target geographic, land-use, and emission rate characteristics of each site and its surroundings, and question 3, which specifically targets emissions sources responsible for haze (including transport on clean/dirty days, urban influences, and seasonal characteristics).

The COHA has compiled SO_2 and NO_x emissions inventories for the WRAP states to help answer these questions. ARS will review the COHA results and the raw data which support them and prepare comprehensive summaries for the AoH Workgroup. ARS' results will be posted on the AoH project Web page (see below) and incorporated into the final report.

3.1.3 Mass and Species Distribution of Emissions

The COHA project is using a type of cluster analysis to illuminate species apportionment to specific source types. There are various other receptor methods which can be used to determine source apportionment. Receptor models are mathematical procedures for identifying and quantifying the sources of ambient air pollutants at a site (receptor), primarily on the basis of concentrations of source tracing chemical species measured at the receptor. Common apportionment methods include chemical mass balance (CMB) and principal component (or factor) analysis. These differ greatly in their complexity and their domains of applicability. A brief overview of each is presented below.

Chemical Mass Balance Analysis

The CMB approach is the method currently supported by EPA's Office of Air Quality Planning and Standards (OAQPS) for particulate source apportionment. The CMB method is based on the idea that the observed concentration of an element or species in the aerosol sample is the linear sum of the contributions from each element or species source. (Finlayson-Pitts, 2000). If the concentration profiles for the various contributing sources are measured, as well as the total concentration, a set of simultaneous equations can be solved to obtain the contribution of each source for that particular element or species. CMB removes the need for unique tracers of sources, but still requires the chemical components of each source to be known.

Emissions inventories need to be examined before a CMB source apportionment to determine which source profiles will be needed and which chemical components must be measured in local source emissions. Some species composition profiles change more profoundly

than others between source and receptor, which may be treatable if the program includes aging effects on aerosols. Categories that are often combined for particulate and/or VOCs are (EPA, 1998):

- Vegetative burning and cooking
- Diesel and gasoline exhaust
- Gasoline evaporative emissions
- Fugitive dust
- Solvents and coatings
- Metals
- Aggregate handling

Model inputs and outputs are summarized below:

CMB Model Inputs	
Source profiles	Source profiles are intended to represent a category of source rather than individual emitters. The number and meaning of these categories are limited by the degree of similarity between the profiles.
Ambient air samples	Chemical data from measurements performed on ambient air must include at least those species in the source profiles that allow sources to be separated.
Source and receptor uncertainty	Realistic input uncertainty values are necessary to weigh the relative importance of input data to model solutions and to estimate uncertainty of the source contribution.
CMB Model Outputs	
Source contribution estimate	Contribution from the source type designated by the profile.
Performance measures	Statistical parameters including the standard error, regression statistics and the percentage of mass that is accounted for by the source apportionment.

Principle Component (Factor) Analysis

Principal component, or factor analysis is based on examining the variations of the concentrations of various elements from their mean value. The data are analyzed to find groups of elements whose changes as a group account for these variations. These groups of elements, which change in such a way as to indicate they are associated with each other, are known as "factors." In the factor analysis approach, the minimum number of factors or elemental groupings needed to explain the observed variations in the composition is sought. Analysis involves a receptor data matrix that is decomposed to find the factors and the weights that are associated with each factor. It is a more complex approach than CMB, but it has the advantage that chemical profiles of the sources are not required and are instead based upon the ambient

data. This is also an inherent disadvantage because it requires significant interpretation of the output profiles.

As an example, some general guidelines for source identification in the northeastern U.S., used as part of preliminary source apportionment analysis by Battelle and Sonoma Technology, Inc., were described as follows (BST, 2002):

- Crustal: Silicon and Aluminum and trace metals
- Residual oil: High sulfate source with vanadium and nickel
- Mobile, also called secondary, OC: Anything characterized by high OC, some EC (strictly less than the OC), very little sulfate, and some metals
- Sea salt: High sodium content, and Mg, Mn
- Vegetative burning: High amounts of K, with OC > EC
- Incinerator: OC > EC, sulfate, and trace metals without V
- Industrial non-oil/non-coal: High sulfate without V or Ni
- Road sand: A wintertime silicon source
- Industrial: Some sodium and with a mix of sulfate, OC, EC, and metals that were otherwise classified
- Power plant: Sulfate, Se, and Ti
- Diesel: EC > OC + sulfate + trace metals
- Smelter: The trace metal: Pb, Zn, Sr, Cu, and/or Ti without OC or EC
- Wood smoke: K, high OC
- Road salt: Na + mobile profile:Na + OC>EC + metals, low sulfate

The crucial assumption is that enough variables representing important processes have been included in the analysis so interpretation of the factors can be related to physically meaningful terms. While CMB analysis can be performed with as little as one complete receptor sample, it has been suggested that the practical lower limit on the number of observations required for factor analysis is 50 to 100 (CAPITA, 1999).

Several models exist that are based on factor analysis, or the closely related principal component analysis. In recent years, the development and investigation of at least three models, RMAPS (Receptor Model Applied to Patterns in Space), UNMIX, and PMF (Positive Matrix Factorization), has been supported by the EPA. In comparison with CMB, less is understood about the behavior and validity of these models. Model inputs and outputs are summarized below:

Principal Component (Factor) Analysis Model Inputs	
Ambient air samples	Chemical data including uncertainties from measurements performed on ambient air
Principal Component (Factor) Analysis Model Outputs	
Source profiles	Identifies source "factors" and the apportionment of the mean species mass for each receptor sample
Performance measures	Statistical parameters indicating uncertainties and goodness-of-fit for factor apportionment
Time series	A time series of the relative source strength at the receptor

Because of the different applications of each type of model, it may be useful to apply more than one method and look for consensus among results. For example, a factor analysis model may help identify important missing sources for use in a chemical mass balance model. Also, the use of a receptor model in conjunction with dispersion modeling may add confidence to source apportionment results, or indicate different results that require reconciliation.

Another example of the benefit of these techniques is in the investigation of organic compounds. Organic mass is the most complex and least understood of the major species that affect visibility, consisting of hundreds of individual compounds. This is of particular importance in parts of the western U.S. due to the prevalence of agricultural burning and wildfires. CMB analysis of organic carbon (OC) collected on IMPROVE filters could prove a significant step to understanding the apportionment of primary OC and estimating the magnitude of secondary OC. Of course, CMB analysis and/or other source apportionment techniques may be used to investigate other source types that cause haze.

Due to the complexity of some of these techniques it may not be feasible or cost effective to perform analyses for all CIAs. Single sites representative of entire sub-regions may be logical choices for analysis.

ARS will carefully review and compare the results of whatever source apportionment method(s) is chosen and regional and sub-regional emissions inventories, and summarize the current understanding of source apportionment in WRAP. Meteorological back trajectory analysis, coupled with the emissions inventories should help to confirm or question source apportionment results. Source apportionment analysis for sites shown to be influenced by sources outside the U.S. will be more challenging to characterize, and will depend heavily upon the accuracy and completeness of emissions inventories outside the U.S. border. Results for these sites will likely have the largest uncertainties.

3.1.4 Natural and Anthropogenic Emissions Impact at Each Class I Area

The EPA has suggested a default method for determining natural background visibility in their Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule (EPA, 2003). It is generally accepted that this is a good starting point, but some significant refinements can be made, including:

- Modification of the calculation natural background conditions of the 20 percent best and worst days.
- Review of the assumed dry scattering efficiencies of several species (organic mass, ammonium sulfate, ammonium nitrate, and course mass).
- Review of impacts from prescribed burns and controlled agricultural burning.
- Review of impacts from wildfires.
- Review of impacts from fugitive dust.
- Review of the effects of sea salt on extinction at coastal sites.
- Review of the magnitude and frequency of Asian dust events.

Each of these refinements is currently being investigated by researchers and RPOs, and it is likely that not all sites would be affected by all refinements of estimated natural background visibility.

Some source apportionment methods can help distinguish between natural and anthropogenic aerosols. For example, the chemical mass balance method, when applied to organic carbon data, can yield contribution estimates of primary and secondary organics, likely source types, and the percent attributable to human activities.

ARS will synthesize the WRAP data analysis and emissions inventories currently completed, and recent literature related to the suggested refinements to EPA's guidelines for determining natural visibility, to provide an estimate (or range) of the split between natural and anthropogenic impacts on each CIA. However, given the number and diverse nature of possible refinements it cannot be expected that absolute, final answers will be determined for each CIA. Uncertainty in this analysis is anticipated to be large.

3.2 TASK 2 – REVIEW AND DISCUSSION

3.2.1 Overall Approach

As the AoH project proceeds, ARS will work closely with AoH Workgroup members and other relevant parties to review, discuss, and document methods and results. Conference calls, workgroup meetings, and the project Web page (see below) will all be used to further this goal. Ultimately, ARS and the AoH Workgroup will formulate specific policy-relevent statements and summaries. Under this task ARS will:

- Document the assumptions and methods used.
- Assess the biases and uncertainties in project data.
- Provide succinct, clear policy-relevant summaries.

3.2.2 Assumption and Methods Used in Integrated Analyses

ARS will develop the methodologies (including all assumptions) used to perform the integrated analyses for Task 1 (see above) in close coordination with the AoH Workgroup. Precedents for some methods may already exist, inherent in previous or current WRAP analyses. ARS will fully and clearly document all steps taken, the reasons the selected methods were chosen, and the reasons other methods were rejected.

3.2.3 Assess Biases and Uncertainties

Data analyses, modeling efforts, and complications of emissions inventories all have inherent biases and uncertainties which are dependant on the specific methodologies used. Biases and uncertainties in measured, modeled, and compiled parameter values are introduced at each step in WRAP's visibility analysis. The biases and uncertainties to be addressed in this project are associated with:

- Emissions Inventories: Inaccuracies are common due to additions, deletions, or changes in stationary sources, time-dependant variability in regional mobile sources, and seasonal/annual/episodic variability of natural sources. Inconsistencies across state boundaries often occur due to differing regulations or reporting conventions.

- Atmospheric/Particulate Models: Model performance can be checked by comparisons with measured data. ARS' experience with modeling performance in the southeastern U.S. implies that for individual species, normalized mean errors of 30 % to 100 % were common. Model performance was considered "reasonable" if it predicted measured species concentrations high or low within a factor of two.

- Meteorological Back Trajectory Models: Back trajectories need to be used with caution. Meteorological models used for these analyses generally do not handle low surface winds and local topography well. Parameters such as trajectory duration, end height, vertical motion, and time of day of end point (especially for a 24-hour aerosol measurement) all need to be considered. Often an aggregate analysis of many trajectories is preferable to a single trajectory.

- Particulate Concentration Analyses: Uncertainties and biases within IMPROVE aerosol data are dependent on sampler operation, lab analysis, and analysis assumptions. These can often be quantified with confidence. Some important factors include:

    - Lack of highly time-resolved mass measurements with 24-hour integrated samples means it cannot be known how the mass loading was distributed throughout the day.
    - Lack of detailed information about collected organic compounds makes the conversion from organic carbon somewhat uncertain.
    - Lack of sulfate acidity measurements may cause errors in the assumed mass of sulfate and nitrate compounds.

- Visibility Calculations from Particulate Concentrations: The largest uncertainties in the IMPROVE aerosol extinction equation are related to:

    - Lack of particle size distribution measurements. Assumed scattering efficiencies may be too low or too high on a given day.

- Lack of sulfate acidity measurements. In the southeastern U.S., ARS has found that when measured ammonium is incorporated into the equation, extinction values in rural areas are approximately 8 % higher on average (greater than 15 % higher on some days) than when modeled with the standard IMPROVE equation. This effect may be considerably less in the western U.S. where sulfate mass is lower, in absolute and percent contribution.
- Choice of relative humidity enhancement factor f(RH). EPA guidance is to use a constant monthly f(RH) value. Extinction calculations made with reliable on-site RH measurements allow for a better estimate of day-to-day extinction, and are required when making comparisons to optical data (collected with a transmissometer or a nephelometer).

ARS understands the types and magnitudes of biases and uncertainties associated with emission inventories, modeling results, and analytical data analyses. Some, however, are difficult to explain quantitatively. ARS will quantify and document where possible, and explain qualitatively where necessary. Much of this information will come from individual reports already prepared or currently in preparation for WRAP. Some biases and uncertainties will result from the assumptions inherent in synthesizing independent data sets.

3.2.4 Policy Level Summaries for each Class I Area

To prepare state and tribal implementation plans and comply with other requirements of the Regional Haze Rule, WRAP participant members need a resource which clearly and succinctly summarizes the current understanding of aerosol composition and visibility conditions at CIAs and the emissions source types, locations, and magnitudes of impact. ARS staff have wide-ranging experience working with governmental and non-governmental stake holder groups, including:

- Visibility Improvement State and Tribal Association of the Southeast (VISTAS): Joe Adlhoch, visibility and air quality assessment lead
- Southern Appalachian Mountain Initiative, (SAMI): Joe Adlhoch, visibility and air quality assessment lead
- The Western Regional Air Partnership, (WRAP) Air Monitoring and Reporting Forum: John Molenar, industry/business representative
- The Grand Canyon Visibility Transport Commission: John Molenar, subcommittee member

Working on or for committees which represent diverse stakeholders (federal land managers, industry, conservation groups, and the public) can be a challenge, but one that ARS has accomplished with success.

ARS will present results and uncertainties for each CIA which are stated clearly, professionally, and in language that is appropriate for use in policy decisions. ARS will not, however, suggest or promote specific policy decisions. All results will be finalized in close coordination with AoH Workgroup members to ensure their applicability and usefulness.

3.3 TASK 3 – ADDITIONAL/RELATED TASKS

The purpose of this section is to address work items that span all project tasks and deliverables. ARS' responses to each component of Task 3 are discussed below.

3.3.1 Support, Facilitate, and Summarize AoH Workgroup Input

ARS will communicate closely with the AoH Workgroup throughout the project, participating in conference calls and workshops, and preparing presentation materials (generally in MS PowerPoint format for ease of distribution). In addition, ARS will summarize input from various workgroup forums and post these summaries on the project Web page (see below).

For the purposes of costing this proposal, ARS has assumed the following travel requirements:

- All AoH workshops will be held in a major western city.
- The ARS principal investigator will attend three (3) workshops outside of Colorado (requires air travel, lodging, meals, etc.), and one (1) workshop in Denver (does not require air travel, lodging, meals, etc.).
- Each workshop spans two (2) days.

3.3.2 Document AoH Workgroup Schedule and Methodology

ARS will work with the AoH Workgroup to prepare an appropriate project schedule and define the methodology used to meet project goals. ARS has worked extensively with consensus-building policy groups, including VISTAS, SAMI, WRAP, and the Grand Canyon Visibility Transport Commission. ARS will update the project Web page (see below) with current schedules and summaries of project methodologies.

3.3.3 Provide and Support an AoH Project Web Page

ARS will develop an AoH project Web page (or pages) to accommodate dissemination of background, scheduling, and analysis information, as well as draft and final Attribution of Haze reports. Web page design will begin in early July, with an initial review scheduled for the July 22-23, 2004 AoH Workshop. A final version will be completed by early August. WRAP is expected to host the Web page, but allow ARS to modify content as necessary. (If required, ARS could host the web page on its server.) The Web page will be updated by ARS bi-monthly or as necessary to ensure that AoH workgroup members have access to recent analyses or other information.

ARS has extensive experience developing and hosting informational Web sites. (Publicly accessible examples are: www.phoenixvis.net; www.air-resource.com; www.hazecam.net; www.fsvisimages.com; and www.wyvisnet.com.) Final Web page design will be developed in conjunction with members of the AoH Workgroup, but will be styled after the "general structure for attribution of haze report" presented in the RFP and will include:

- Background on WRAP and Attributions of Haze project
- Summary of previous work (analysis, modeling, emissions inventories, other), including appropriate links
- AoH project schedule (conference calls, meetings, deliverable due dates)
- AoH project methodologies
- Draft and final reports
- Site-by-site summaries of AoH project work described in Tasks 1 and 2

It is anticipated that the site-by-site summaries will comprise the majority of the information on the project Web page. This information will be databased to allow retrieval of results for individual sites, entire states or tribal domains, and specified sub regions (e.g., Pacific Northwest; Rock Mountains; etc.).

The AoH Web page will be an important channel of communication between ARS and the AoH Workgroup, as well as other WRAP participants and interested parties. Once the project is complete, the AoH Web page will be a comprehensive resource and reference for states, tribes, and the public.

3.3.4 Review, Process, Format, and Manage Available Data Analyses and Reports

ARS will review, process, format, and manage available data from:

- Source apportionment modeling simulations from the WRAP Regional Modeling Center
- Back trajectory and receptor-oriented analyses of aerosol monitoring data from the WRAP Causes of Haze Assessment
- Emissions inventories prepared by WRAP
- Special studies such as BRAVO, GRAVS, MOHAVE, and PREVENT
- EPA technical guidance on regional haze
- Journal publications
- Other available Regional Planning Organization (RPO) sources

This work will be an integral part of Tasks 1 and 2. All sources will be incorporated into the project Web page as links to other Web sites or documents. Conclusions from ARS' analyses requiring a synthesis of these sources will be posted on the project Web page as appropriate, and included in the final report.

3.3.5 Compile Topic Reports from Independent Experts

If ARS and the AoH Workgroup determine that additional reports are required beyond those already finished or in progress, the AoH Workgroup may contract directly with independent experts. ARS has good working relationships with visibility monitoring and modeling experts across the country and can assist the AoH Workgroup with defining the scope and structure of additional reports. ARS will work with the selected independent experts to facilitate scheduling and preparation of final documents. These documents will be added to the project Web page and their conclusions incorporated into the ARS analysis, as appropriate.

If independent expert reports are required, it is critical that the scope and completion schedule of those reports be reasonable and well defined to keep the overall AoH project on schedule.

3.3.6 Prepare an AoH Project Report

ARS will work with the AoH Workgroup to define the structure and outline of the final report. Due to the comprehensive and regional nature of the project, as well as the potential need for additional independent expert reports, two draft versions of the report will be required. ARS proposes the following schedule (subject to modification as the project progresses):

- Approval of draft report outline, September 2004
- Submittal of first report draft for internal AoH review, in conjunction with in-person presentation, October 2004
- Review comments on first report draft due within 3 weeks of submittal by ARS
- Submital of second report draft for internal and external review, November/December 2004
- Review comments on second report draft due within 3 weeks of submittal by ARS
- Final Attribution of Haze report published (bound version and digital Web version), January 2005

ARS considers the overall schedule for this project to be aggressive, and as such, it will be important for review of draft reports to occur as scheduled.

It is anticipated that the final report will follow the structure suggested in the RFP, including the following sections:

- Problem statement
- Process of AoH Workgroup
- Process accomplishments
- Level of confidence in final analysis
- Summary of results by state and tribe
- Discussion of regional issues
- Evaluation of potential effectiveness of results
- Recommendations for future phases of the AoH project

All statements, conclusions, and recommendations offered in the final report will be supported by documented research, reports, and links in the site-specific CIA reports posted on the AoH project Web page.

Approximately 50 copies of the final report, professionally printed and bound, will be generated and delivered to the AoH Workgroup. A PDF version of the final report will be posted on the project Web page. AoH Workgroup members will have access to more detailed information included in the site-specific Class I area reports which will also reside on the project Web page.

4.0 SCHEDULE AND DELIVERABLES

Work on this project will begin immediately upon contract award. The proposal project schedule and deliverable products are summarized in Table 4-1. The contents of specific deliverables are detailed in Section 3.0. For this proposal, an award date of June 21 is assumed. Contact with WRAP staff will begin immediately upon contract award. It is anticipated that the first meeting with the AoH Workgroup will occur during the planned July 22-23 meeting. To meet the project objective of a final report in January 2005, the schedule is aggressive. ARS is committed to meeting the schedule.

The availability of information from other WRAP forums, the need for additional information that may require independent WRAP contracts, availability of the AoH Workgroup membership, and unforeseen other factors may affect the schedule. ARS will work with the WRAP staff to adjust the schedule as required.

Table 4-1

Proposed Schedule and Deliverables
Attribution of Haze Project

Date	Description
June 21, 2004	Contract award authorization to proceed.
June 23, 2004	First in-person meeting or conference call among ARS and WRAP staff to establish working relationship and project schedule.
July 6, 2004	Begin development of AoH project Web page.
July 22-23, 2004	First meeting with AoH Workgroup to define project, schedule, and expectations. Begin AoH coordination and directed work. AoH review of project Web site.
July – August, 2004	Obtain, review and analyze available data and reports (including reports from WRAP Regional Modeling Center and Causes of Haze projects).
August 6, 2004	Finalize AoH Project Web page on the WRAP Web site.
August – September, 2004	Continue to refine project schedule based on availability and expected availability of information. Identify the need for additional information and WRAP assignments to expert review contractors.

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Table 4-1 (Cont.)

Proposed Schedule and Deliverables
Attribution of Haze Project

Date	Description
September - October 2004	Obtain approval of a draft report outline and prepare a preliminary draft of the Attribution of Haze Report. Present findings, including first draft of the Project Report, to the AoH Workgroup for review and discussion. Obtain Workgroup comments on draft report within three (3) weeks of ARS' submission. Begin to refine the findings to represent the consensus policy-level explanations agreed to by the AoH Workgroup. Obtain, review and analyze additional inputs from Regional Modeling Center, Causes of Haze Project, and other information.
November – December 2004	Obtain, review, and analyze draft expert review reports. Prepare, present, and review (internal and external) second draft report. Obtain Workgroup and external comments on draft report within three (3) weeks of ARS' submission.
January 2005	Prepare and publish final Attribution of Haze Report. Plan for subsequent AoH Workgroup activities.

5.0 KEY TECHNICAL PERSONNEL

A brief summary of the qualifications of the proposed key technical personnel are presented below. Résumés for key technical personnel are presented in Appendix A. This team will be supported by the remainder of the ARS staff as required. All key personnel are immediately available to begin work upon contract award and will be committed to the successful completion of this effort.

Principal Investigator – Joseph P. Adlhoch

Mr. Adlhoch has over 10 years experience in managing and performing visibility-related monitoring and analytical contracts. He will be the primary ARS contact for all components of this effort. He will manage the entire effort and perform or supervise the majority of the technical and analytical tasks. He will meet with project participants, prepare all reports, and present results. Joe's experience encompasses leading efforts similar to this Attribution of Haze Project. For example, Joe was the principal investigator for visibility-related Southern Appalachian Mountains Initiative (SAMI) and Visibility Improvements – State and Tribal Association of the Southeast (VISTAS) projects and has led analytical efforts for a number of state and tribal contracts. Joe has a strong background in visibility science and policy and is a excellent writer, communicator, and consensus builder. Joe is available to dedicate the level of effort required to provide the leadership, coordination, and scientific and policy expertise necessary to ensure project success.

Project Scientist – Cassie M. Archuleta

Ms. Archuleta holds a master's degree in atmospheric chemistry and has 4 years working experience in air and water quality data analysis. She will support technical aspects of the information and data collection, review analysis, and reporting components of all tasks. She will also be responsible for continuing maintenance of the project Web page.

Internal Peer Review – John V. Molenar

Mr. Molenar has over 20 years experience in the environmental sciences and is a nationally-recognized visibility expert. John has been an integral component of the evolving visibility discipline. He has served on the aerosol, optical, and public advisory committees of the Grand Canyon Transport Commission (GCVTV) and is currently a member of the WRAP Air Monitoring and Reporting Forum. John will provide internal peer review of all analyses and reports and will contribute to specific analyses or reviews as needed.

6.0 CORPORATE OVERVIEW AND EXPERIENCE

6.1 QUALIFICATIONS AND EXPERIENCE SUMMARY

Air Resource Specialists, Inc. (ARS) provides professional consulting and support services in air quality-related environmental monitoring, analysis, modeling, compliance, and auditing. Formed in 1981, ARS has successfully conducted a wide range of applications and research contracts for federal, state, and local agencies, and industrial clients. ARS staff includes more than 50 scientists, field specialists, and support personnel with over 300 years of combined experience in environmental disciplines. Areas of special expertise include: visibility, criteria pollutant, and meteorology monitoring, data analysis, database management, research, audit, and instrument services, visibility and air quality modeling, and environmental compliance. These strengths are more fully described in Appendix B and on the ARS Web site at: http://www.air-resource.com.

Specific to this proposal, ARS is nationally recognized for its expertise in visibility monitoring, modeling, analysis, and research. ARS maintains visibility monitoring networks and has performed special studies for federal land management agencies, state agencies, municipalities, Indian nations, and private industry. ARS currently supports over 150 air quality-related sites nationwide including 50 visibility monitoring sites, and is the prime contractor to the IMPROVE Program, the U.S.D.A. Forest Service, and National Park Service Visibility Monitoring and Data Analysis Programs, and the National Park Service Gaseous Pollutant Monitoring Program. To service these monitoring programs, ARS has developed, implemented, and applied a comprehensive air quality database and related data validation, analysis, and reporting tools. The corporation is a recognized leader in the development and operational implementation of visibility-related monitoring and modeling technology. ARS provides comprehensive visibility data analyses and interpretation to federal, state, and tribal agencies including the National Park Service, U.S.D.A. Forest Service, U.S. Fish and Wildlife Service, Environmental Protection Agency (EPA), Southern Appalachian Mountains Initiative (SAMI), Visibility Improvements - State and Tribal Association of the Southeast (VISTAS), Tahoe Regional Planning Agency, Arizona, Wyoming, and other state and tribal programs. ARS also provides monitoring network support and real-time digital image and data Web pages for RPOs including, NESCAUM, VISTAS, LADCO, and CENRAP as well as state and federal agencies and industry.

ARS' visibility-related expertise also includes: design, implementation, coordination, and analysis for major visibility field programs and special studies including: WHITEX, Denver Brown Cloud, Southern Utah Intensive, Phoenix/Tucson Urban Haze, PREVENT, MOHAVE, SCENES, Dallas/Fort Worth Visibility Study, the Mount Zirkel Reasonable Attribution Study of Visibility Impairment, SEAVS, GRAVS, the Northern Front Range Air Quality Study, ACE-2, and BRAVO.

The professional, experienced staff offered in this proposal are immediately available to support the Attribution of Haze Project.

6.2 RELATED PROJECT EXPERIENCE

Table 6-1 lists five selected ARS projects that include technical requirements similar to the Attribution of Haze Project. ARS would be happy to provide additional project references if requested.

Table 6-1

Five Selected Visibility-Related Projects
Air Resource Specialists, Inc.

Customer/Period of Performance	Contact	Description	Contract Value * (Budget to Date)
VISIBILITY MONITORING, MODELING, AND DATA ANALYSIS			
Southern Appalachian Mountains Initiative (SAMI) Contract 032 2000 - 2002	Pat Brewer SAMI Technical Coordinator 2090 US Highway 70 Swannanoa, NC 28778 828-296-4500	Comprehensive analysis of visibility data collect in the 8-state SAMI region. Project includes characterization of future visibility impacts based on aerosol and meteorological model results and compliance with a variety of emissions reduction strategies. ARS created custom software analysis tools for the SAMI Visibility Effect Subcommittee. These tools integrate monitored aerosol and meteorological data, model analysis results, and the effects of SAMI emission strategies.	$70,989 (FP)
Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) Contract V-2002-01 2002 - Present	Pat Brewer VISTAS Technical Coordinator 2090 US Highway 70 Swannanoa, NC 28778 828-296-4500	Comprehensive analysis of particulate mass and visibility data in the 10-state VISTAS region including: compilation of relevant national, regional, state, and special study databases; spatial, temporal, and chemical characteristics of PM and light extinction; inter-network comparisons; sensitivity analyses regarding the IMPROVE extinction equation; meteorological back trajectory analysis associated with high and low extinction days; and data gap analyses.	$150,000 (FP/CPFF)
Arizona Department of Environmental Quality (EV02-0075, 96-0166AA) 1997 - Present	Michael Sundblom Arizona Department of Environmental Quality 1110 W. Washington St. Phoenix, AZ 85007 602-771-2364	Operational support of up to 10 nephelometer and aerosol monitoring sites in Arizona Class I wilderness areas. Services include instrument maintenance, troubleshooting support, data collection, reduction, validation, and reporting. Analysis tasks include integration of data from other regional and national monitoring networks.	$747,570 (FP)
Tahoe Regional Planning Agency 1988 - Present	Jennifer Quashnick Tahoe Regional Planning Agency 308 Dorla Court Zephyr Cove, NV 89448 702-588-4547	Consultation, design, installation, and operation of a comprehensive visibility monitoring program for TRPA. The program consists of optical, particulate, and meteorological monitoring in the Tahoe Basin. Existing visual air quality will be determined and extinction budgets calculated from data. Annual reports are prepared to assess how well the basin air quality complies with established regulatory levels.	$1,186,989 (FP)
Visibility Characterization for Class I Areas in North Dakota, South Dakota, and Montana USEPA Region VIII Contract 8X-0308-NASS (North & South Dakota) and 8X-0315-NASA (Montana) 1998 - 1999	Kevin Golden US Environmental Protection Agency Region VIII 999 18th Street Denver, CO 80202-2405 303-312-6442	Developed an inventory of available IMPROVE and other visibility-related data in Class I areas in North Dakota, South Dakota, and Montana. Developed extinction budgets based on IMPROVE aerosol data. Assessed historical trends in visibility conditions. Reviewed State regulatory control programs impacting visibility precursor emissions and provide recommendations for improvement.	N & S Dakota $19,790 Montana $17,129 (CPFF)

* Contract Type: CPFF - Cost Plus Fixed Fee TO - Task Order FP - Fixed Price

7.0 COST PROPOSAL

ARS proposes to perform this work as a cost plus fixed fee contract using ARS' standard government rates. ARS believes a cost plus fixed fee contract is the most appropriate mechanism for air quality work of this nature where both informed decisions and unforeseen circumstances could result in adjustments to the program.

ARS cost proposal for the Attribution of Haze Project is $88,520. The total number of labor hours proposed is 1,116 over a seven (7) month period. The components of this cost proposal by task and total are presented in Table 7-1. A detailed spreadsheet including labor hours and all costs by task is provided as Table 7-2. This cost proposal is valid for 120 days.

Table 7-1

Cost Proposal
Attribution of Haze Project

Task	Title	Estimated Cost
1	Analysis	$26,141
2	Review and Discussion	$18,910
3	Additional/Related Tasks	$43,470
	Total All Tasks	**$88,520**

Financial control of this project will be direct and responsive. ARS will closely monitor the technical progress and project expenditures against project schedules and budget to ensure the highest quality performance. All accounting and fiscal controls necessary to complete and accurately track project expenditures are in place and have been successfully applied to support the range of ARS contracts.

Monthly invoices for this project will be prepared. Invoices will be submitted by the 15th of the month following the month of record. Payment terms are Net 30.

ARS will be the prime contractor for this effort. No significant subcontracts, if any, are anticipated.

All financial records for this project will be maintained for a minimum of five (5) years or otherwise required by the contract. Files will be available at ARS for review.

7.1 STATEMENT OF CORPORATE FINANCIAL CONDITION

The financial condition of ARS is sound. The scope of this proposed contract effort is well within ARS' financial capability to perform. With more than six million dollars in annual revenue, this project will not place any undue stress or burdens on the corporation.

7.2 INSURANCE COVERAGES

ARS will act as a full and independent contractor and is fully insured to cover all contingencies. ARS' standard insurance coverages are listed in Table 7-3. These coverages meet or exceed the minimum limits specified in the RFP. ARS will provide certificates of insurance to the WGA within 10 working days of contract award and will name the WGA as an additional insured.

7.3 WRAP TERMS AND CONDITIONS

ARS has read, agrees to, and will abide by all of the WRAP terms and conditions stated in the Attribution of Haze RFP.

7.4 CONFLICT OF INTEREST STATEMENT

ARS does not now have or will it acquire any interest, direct or indirect, which would pose a conflict of interest in any manner or degree with the performance of this contract.

Table 7-3

Air Resource Specialists, Inc.'s
Standard Coverages for Air Quality-Related Projects

Type	Provider	Policy Number	Amount	Description
Comprehensive General Liability and Professional Liability	Admiral Insurance		$1,000,000 - Each Occurrence $3,000,000 - General Aggregate $3,000,000 - Products - Completed - Operations Aggregate	Products - Completed Operations, Contractual Liability, Underground Hazards, Personal Injury, Advertising Injury Professional Liability
Automobile	The Hartford		$1,000,000 - Each Occurrence $5,000 - Each Person $1,000,000 - Each Occurrence $50,000 - Comprehensive/Unit $50,000 - Collision/Unit	Owned Auto Liability Medical Payments - Commercial Uninsured Motorist Bodily Injury Hired Auto Liability Hired Auto Collision
Workers' Compensation	Pinnacol Assurance	1477552	As Described by Colorado Workers' Compensation Act	Standard Comprehensive Workers' Compensation and Employer's Liability Policy

8.0 REFERENCES

Battelle and Sonoma Technology, Inc. (BST), (2002), Mid-Atlantic/Northeast Visibility Union (MANE-VU) Source Apportionment Analysis of Air Quality monitoring Data: Phase 1, Final Report, May.

Center for Air Pollution and Trend Analysis (CAPITA), (1999), Quantifying the Contribution of Important Sources to PM Concentrations, PM Data Analysis Workbook: Source Apportionment, http://capita.wustl.edu/PMFine/Workbook/PMTopics_PPT/WB_SourceAttr/Version2/tsld001.htm, October.

Causes of Haze Assessment (COHA) web site (2004), http://coha.dri.edu/index.html.

EPA (2003), Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, September 2003 (EPA-454/B-03-005).

EPA (1998), CMB8 Application and Validation Protocol for $PM_{2.5}$ and VOC, October, (EPA-454/R-98-XXX).

Finlayson-Pitts (2000), Chemistry of the Upper and Lower Atmosphere, Academic Press, pp. 386-388.

APPENDIX A

RESUMES

JOSEPH P. ADLHOCH
Principal Investigator
Air Resource Specialists, Inc.

PROFILE

Mr. Adlhoch has 11 years experience performing and managing the technical aspects of visibility monitoring programs including performing instrument installation and servicing, data analysis, research, and reporting. His background includes statistical analysis and instruction.

EDUCATION

M.S. Candidate, Atmospheric Science — Colorado State University, 2001
B.S., Physics and Astronomy — University of Arizona, 1987

EXPERIENCE

AIR RESOURCE SPECIALISTS, INC. – PROJECT SCIENTIST / INFORMATION MANAGEMENT SECTION MANAGER 1993 – Present

Responsible for technical supervision, data analysis, and reporting for a wide variety of federal, state, and special study ambient air quality and visibility monitoring networks. Specific responsibilities include:

- Supervising technical aspects of federal, state, and private visibility and ambient air quality monitoring networks.
- Managing overall activities of the air quality Information Management Center.
- Preparing seasonal and annual data summary and analysis reports.
- Installing, servicing, and auditing instrumentation and support equipment at field locations.
- Training site operators in routine operation of instrumentation.
- Performing statistical data analysis and interpretation.
- Producing training and informational video products.

Sample project experience includes:

- *Visibility Improvement – State and Tribal Association of the Southeast (VISTAS)*: Technical lead for visibility and particulate characterization study in the 10-state VISTAS region. Comprehensive analyses performed on IMPROVE, SEARCH, and EPA STN speciated aerosol data to identify spatial and temporal patterns. Project included an analysis of monitoring data gaps within the region.

WESTERN AREA POWER ADMINISTRATION - CONSULTANT 1993

Responsible for developing PC-based software for U.S. Department of Energy power repayment studies.

HODGES ENGINEERING - CONSULTANT 1992-1993

Responsible for ongoing design and manufacturing support for a variety of scientific instruments used in the fields of gas chromatography and meteorology.

MSA/BASELINE INDUSTRIES – PROJECT ENGINEER 1990-1992

Responsible for new instrument development and manufacturing support, including software design, prototype testing, user's manual and training video preparation, and instrument servicing.

UNIVERSITY OF ARIZONA - INSTRUCTOR 1986-1990

Responsible for developing and teaching an introductory astronomy lab course. Also worked on a team to develop an academic support program for learning disabled students.

PIMA COMMUNITY COLLEGE - INSTRUCTOR 1988-1989

Responsible for physics lab preparation and instruction.

STEWARD OBSERVATORY - RESEARCH ASSISTANT 1983-1986

Participated in a study of extragalactic radio sources. Operated optical and radio telescopes, and reduced and correlated data from both. Worked on a team to develop software to analyze data from the observatory's CCD Transit Instrument. Also served as a telescope operator/manager, responsible for student and public education.

TRAINING AND RELATED SKILLS

Aerosol Chemistry
Optical, aerosol, and meteorological monitoring instrumentation
Computer programming languages (BASIC, FORTRAN)
Analytical and graphics software
Statistics

PUBLICATIONS AND PAPERS

Adlhoch, J.P, Cismoski, D.S., Savig, K., Sundblom, M., Anderson, D., George, M., 2003, Implementation of the Phoenix Visibility Monitoring Network, AWMA Annual Meeting, San Diego, California, June.

Adlhoch, J.P, Brewer, P., Boylan, J., Imhoff, R., 2001, An Assessment of Visibility Responses in the Southern Appalachian Mountains to Selected SAMI Emissions Strategies, AWMA Visibility Specialty Conference, Bend, Oregon, October.

Adlhoch, J.P, Tigges, M., Freet, B., Yow, G., 2001, Assessment of Ambient Air Quality During Spring Dust Events at Lake Chelan National Recreation Area, AWMA Visibility Specialty Conference, Bend, Oregon, October.

Adlhoch, J.P, J.V. Molenar, D.L. Dietrich, and C.T. Moore, 2000, Field Test Results of the Optec NGN-3 PM2.5 Size-cut Nephelometer, AWMA Visibility Annual Meeting, Salt Lake City, Utah, June.

Moore, C.T., M. Fitch, J.P. Adlhoch, P. Lahm, 2000, Effects of Filtering Optical Visibility Measurements for Rate-of-Change on Class I Areas Data Distributions, AWMA Specialty Conference, PM2000: Particulate Matter and Health, Charleston, South Carolina, January.

CASSIE M. ARCHULETA
Project Scientist
Air Resource Specialists, Inc.

PROFILE

Mrs. Archuleta has recently joined ARS with a background in atmospheric science, chemistry and mathematics.

EDUCATION

M.S., Atmospheric Science — Colorado State University, 2003
B.A., Mathematics (minor in Chemistry) — Adams State College, 1998

EXPERIENCE

AIR RESOURCE SPECIALISTS, INC. – DATA ANALYST 2003 – Present

Responsible for data analysis and reporting for a wide variety of federal, state, and special study ambient air quality and visibility monitoring networks. Specific responsibilities include:

- Preparing quarterly and annual data summary and analysis reports.
- Performing statistical data analysis and interpretation.
- Analytical support of visibility special studies and research.

Sample project experience includes:

- *Wyoming Department of Environmental Quality* Perform data analysis, interpretation, and reporting for the Wyoming Visibility Monitoring Network. The monitoring program includes remote sites that operate camera systems; transmissometer, nephelometer, meteorological instrumentation; data collection systems, aerosol monitors, and gaseous monitoring instrumentation.

- *Tahoe Regional Planning Agency*: Perform data analysis, interpretation, and reporting for the Tahoe Regional Planning Agency. The monitoring program includes remote sites that operate nephelometer and meteorological instrumentation; data collection systems, and aerosol monitors.

COLORADO STATE UNIVERSITY – GRADUATE RESEARCH ASSISTANT 2000 – 2003

Responsible for performing laboratory studies using a custom-made ice-nucleating instrument to study cirrus cloud formation. Analysis included the role of metal oxides associated with sulfate groups as ice nuclei.

NORTHERN COLO. WATER CONSERVANCY DISTRICT – LAB SUPERVISOR 1999 – 2000

Responsible for supervising laboratory operations supporting the Irrigation Management Services division of the NCWCD. Performed collection and laboratory analysis of soil, water, and plant tissue samples, drafting of QC/QA documents for salinity research, and calibration, operation, and comparison of several regional soil nitrogen leaching models.

TRAINING AND RELATED SKILLS

IBM PC-compatible computers
MS-DOS operating system and software
IBM PC-based word processing software (MS Word)
IBM PC-based analytical and graphics software (MSExcel, MSPowerPoint, MSAccess)
Statistics

JOHN V. MOLENAR
Internal Peer Review/Senior Scientist
Air Resource Specialists, Inc.

PROFILE

Mr. Molenar has over 25 years technical experience in environmental sciences. His expertise covers a broad range of research and applications projects, including visibility monitoring and modeling, ambient air quality and meteorological monitoring, atmospheric physics, snow hydrology, air resource related radiation transfer and pollution dispersion modeling, and management of major field study programs. He has special expertise, and is a recognized principal scientist in visibility monitoring and research.

EDUCATION

M.S., Atmospheric Physics — University of Nevada, Reno, 1979
B.S., Physics — Northern Arizona University, 1976

EXPERIENCE

AIR RESOURCE SPECIALISTS, INC. – VICE PRESIDENT/SR SCIENTIST 1983 – Present

Responsible for development and execution of research and support services in:

- Modeling and measurement of atmospheric electro-optical parameters, including:
  - Radiation transfer modeling of visual air quality
  - Computer imaging of atmospheric visibility
  - Development of new equipment and techniques to measure the electro-optical properties of the atmosphere
  - Field management of special studies to measure atmospheric optical properties
  - Data analysis and interpretation
- Modeling and measurement of human psycho-physical perception of visual air quality.
- Preparing technical reports and proposals.
- Project management and business development.

JOHN MUIR INSTITUTE FOR ENVIRONMENTAL STUDIES, INC. – DIRECTOR 1979-1983

Responsible for all operations and research projects carried out by the Visibility Research Center. Projects included the EPA-NPS Visibility Monitoring Network, BLM Visibility Monitoring in Colorado, NPS contracts for computer imaging of visibility degradation and development of radiation transfer models for visibility modeling, and NPS contracts for the development of telemetry systems for automatic collection of visibility data. Duties included business development, project management, training and presentations, computer modeling, data analysis and interpretation, field program development, and preparation of technical reports and proposals. Also served as a staff Scientist and Principal Investigator on projects, including computer modeling and imaging of visibility impairment, human perception of visual air quality, and EPA-NPS Visibility Monitoring Network data analysis and interpretation.

UNIVERSITY OF NEVADA – DESERT RESEARCH INSTITUTE – RESEARCH ASSISTANT 1977-1979

Graduate student responsible for support of field and laboratory research. Field work included snow surveys, snow sampling and analysis using ultra-clean techniques, use and maintenance of meteorological instruments, and a mountain field station for the weather modification experiments carried out by the institute. Laboratory experience included analysis of snow samples from the Sierra Nevada Mountains and the Ross Ice Shelf in the Antarctic, for trace metals by flame and flameless atomic absorption spectrometry. Also performed computer analysis of storm and chemistry data, including program analysis and development.

NORTHERN ARIZONA UNIVERSITY – LABORATORY ASSISTANT 1973-1977

Responsible for various projects in the Air and Water Quality Measurement Laboratory, while an undergraduate student. Air quality related projects included the Lake Powell Research Project, the Flagstaff Air Quality Study, Computer Modeling of Atmospheric Dispersion, and various visibility experiments.

TRAINING AND RELATED SKILLS

Optical monitoring instrumentation (transmissometers, nephelometers, lidar, and photographic systems)
Aerosol monitoring and physical/chemical analyses
Ambient air quality/meteorology field instrumentation
Visual air quality modeling
Instrument-rated pilot

SOCIETIES AND AFFILIATIONS

Air & Waste Management Association (A&WMA)
International Society for Optical Engineering (SPIE)
The Society for Imaging Science and Technology (IS&T)
Optical Society of America (OSA)
Grand Canyon Visibility Transport Commission: Public Advisory Committee and Aerosol and Visibility Subcommittee
Western Regional Air Partnership: Ambient Monitoring and Reporting Forum and Research and Development Forum

PUBLICATIONS AND PAPERS

Selected journal publications and conference proceedings include:

JOURNAL PUBLICATIONS

Johnson, C. E., W. C. Malm, G. Persha, J. V. Molenar, and J. R. Hein, Statistical Comparisons Between Teleradiaometer Derived and Slide Derived Visibility Parameters, *JAPCA, 35,* 1261-1265, 1985

Malm, W. C., K. Kelly, J. V. Molenar, and T. C. Daniel, Human Perception of Visual Air Quality (Uniform Haze), *Atmospheric Environment, 15,* 1875-1890, 1981

Malm, W. C., J. V. Molenar, and L. L. Chan, Photographic Simulation Techniques for Visualizing the Effects of Uniform Haze on a Scenic Resource, *JAPCA, 33,* 126-129, 1983

Malm, W. C., K. A. Gebhart, J. V. Molenar, T. A. Cahill, R. A. Eldred and D. Huffman, Examining the Relationship Between Atmospheric Aerosols and Light Extinction at Mount Rainier and North Cascades National Parks, *Atmospheric Environment, 28*, 347-360, 1994

Malm, W. C., J. V. Molenar, R. A. Eldred and J. F. Sisler, Examining the Relationship Among Atmospheric Aerosols and Light Scattering and Extinction in the Grand Canyon Area, *Journal of Geophysical Research , 101*, 19, 251-19,265, 1996

White, W. H., E. S. Macias, J. D. Kahl, P. J. Samson, J. V. Molenar and W. C. Malm, On the Potential of Regional-Scale Emissions Zoning as an Air Quality Management Tool for The Grand Canyon, *Atmospheric Environment, 28,* 1035-1045, 1994

CONFERENCE PROCEEDINGS

Cismoski, D. S., D. L. Dietrich, and J. V. Molenar, Design and Field Operation of the Optec NGN-2 Nephelometer, in: *Aerosols and Atmospheric Optics: Radiative Balance and Visual Air Quality*, 905-921, Air and Waste Management Association, Pittsburgh, Pa., 1994

Dietrich, D. L., M. A. Klitch, D. S. Cismoski, and J. V. Molenar, An Assessment of the Accuracy and Precision of Photographic Densitometric Measurements for Monitoring Visual Air Quality, in: *Transactions: Visibility and Fine Particles,* pp. 281-292, C. V. Mathai Editor, Air and Waste Management Association, Pittsburgh, Pa., 1989

Golestani, Y., C. E. Johnson, and J. V. Molenar, Error Modeling in an Image Processing System for Visual Air Quality, in: *Aerosols and Atmospheric Optics: Radiative Balance and Visual Air Quality*, 965-966, Air and Waste Management Association, Pittsburgh, Pa., 1994

Molenar, J. V., G. Persha, and W. C. Malm, Long Path Transmissometer for Measuring Ambient Extinction, in: *Proceedings of Environment and Pollution Measurement Sensors and System, Volume 1269,* pp. 37-55, SPIE - The International Society for Optical Engineering, Bellingham, Washington, 1990

Molenar, J. V., D. S. Cismoski, and R. M. Tree, Intercomparison of Ambient Optical Monitoring Techniques, in: *Proceedings of AWMA 85th Annual Meeting & Exhibition: Air Monitoring,* paper 92-60.09, Air and Waste Management Association, Pittsburgh, Pa., 1992

Molenar, J. V., Response to "Recommendations for Monitoring the Effects of Air Quality on Visibility", in: *Aerosols and Atmospheric Optics: Radiative Balance and Visual Air Quality*, 16-17, Air and Waste Management Association, Pittsburgh, Pa., 1994

Molenar, J. V., Atmospheric Extinction Monitoring in Urban Areas, in: *Aerosols and Atmospheric Optics: Radiative Balance and Visual Air Quality*, 33-44, Air and Waste Management Association, Pittsburgh, Pa., 1994

Molenar, J. V., Analysis of the Real World Performance of the Optec NGN-2 Ambient Nephelometer, in: *Visual Air Quality: Aerosols and Global Radiation Balance,* 243-265, Air and Waste Management Association, Pittsburgh, Pa., 1997

Molenar, J. V., R. Henry, and S. Mahadev, Comparison of Measured and Modeled High Resolution Sky Spectral Radiance Data, in: *Visual Air Quality: Aerosols and Global Radiation Balance,* 407-418, Air and Waste Management Association, Pittsburgh, Pa., 1997

Sisler, J. F., W. C. Malm, K. A. Gebhart, J. V. Molenar, and T. Cahill, The Effect of Relative Humidity on Visibility - Continental Distributions, in: *Proceedings of AWMA 85th Annual Meeting & Exhibition: Air Monitoring,* paper 92-60.03, Air and Waste Management Association, Pittsburgh, Pa., 1992

APPENDIX B

CORPORATE OVERVIEW

B.0 CORPORATE OVERVIEW AND KEY TECHNICAL PERSONNEL

B.1 CORPORATE OVERVIEW AND CAPABILITIES AIR RESOURCE SPECIALISTS, INC.

Air Resource Specialists, Inc. (ARS) provides professional consulting and support services in air quality-related environmental monitoring, analysis, modeling, compliance, and auditing.

Formed in 1981, ARS has successfully conducted a wide range of applications and research contracts for federal, state, municipal, and tribal agencies, and industrial clients. ARS staff includes more than 50 scientists, field specialists, and support personnel with over 300 years of combined experience in environmental disciplines. An organizational chart of the corporation is presented in Figure B-1.

Corporate headquarters in Fort Collins, Colorado, includes office, computer, laboratory, and shop facilities fully equipped to meet the most challenging ambient air quality, meteorology, and visibility monitoring, analysis, modeling, compliance, and auditing requirements.

ARS services clients throughout North America and has demonstrated project management experience in both government and industrial environments. The staff maintains close, cooperative, and professional working relationships with its clients. Services are provided through personal, team, and management consulting agreements and are generally performed out of the corporate offices in Fort Collins.

Areas of special expertise include: criteria pollutant, visibility, and meteorology monitoring; data analysis; research, audit, and instrument services; air quality and visibility modeling; and environmental compliance. These strengths and experience are briefly described below, in the corporate brochures provided on the ARS Web site at:

http://www.air-resource.com

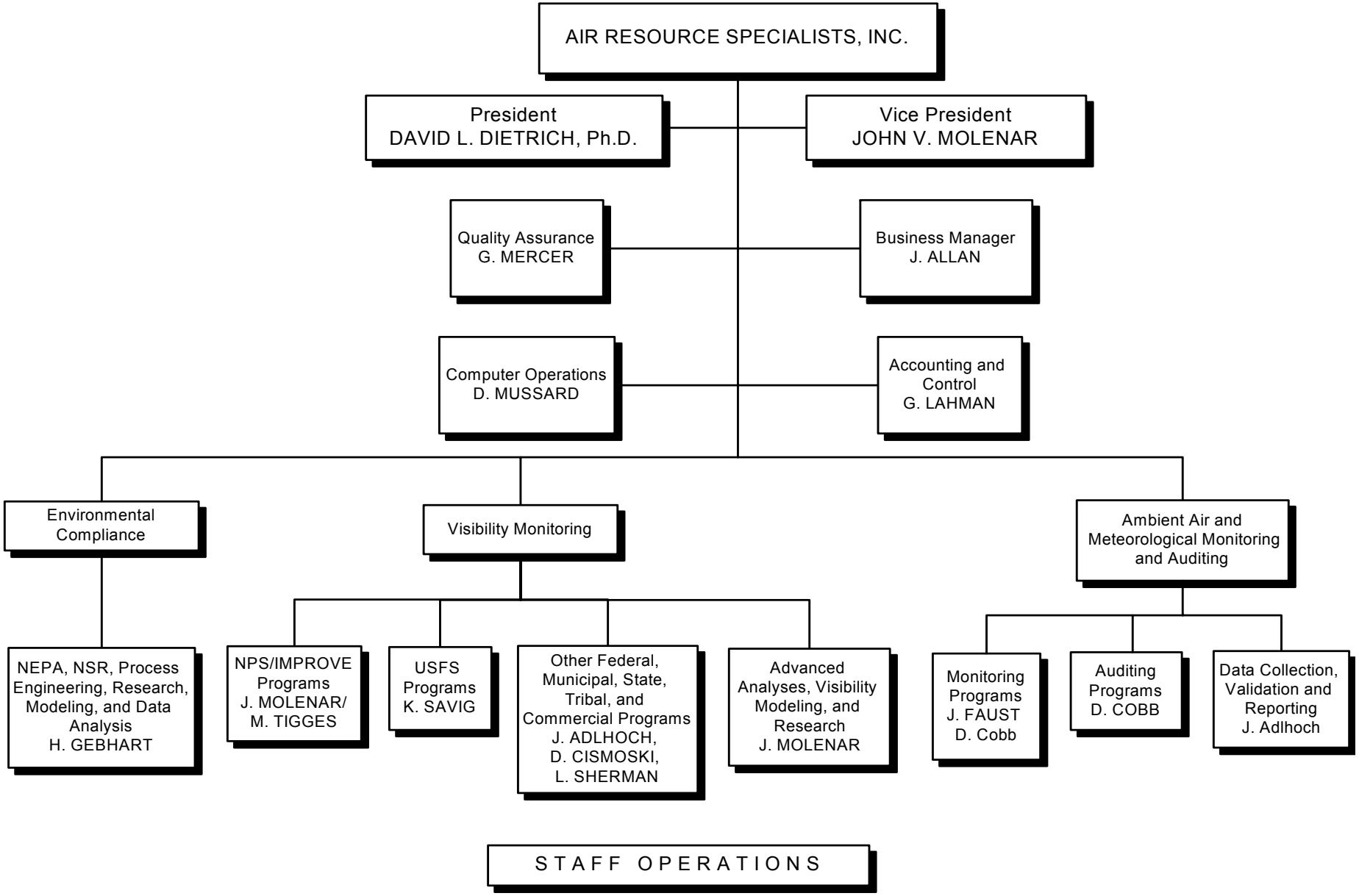

Figure B-1. Corporate Organization - Air Resource Specialists, Inc.

Criteria Pollutant and Meteorology Monitoring, Data Analysis, Auditing, and Instrument Services

ARS maintains and supports criteria pollutant and meteorological monitoring networks for operational, PSD, and research applications. ARS also provides continuing support to over 50 monitoring sites nationwide, including government and private networks in urban, rural, and remote areas. ARS is the prime contractor to the National Park Service Gaseous and Meteorological Monitoring Network. Operational field, data collection, analysis, and audit services are supported by a fully-equipped air quality laboratory with diagnostic tools and support equipment to certify, calibrate, and repair air quality and meteorological instrumentation, data loggers, and electronic and mechanical support systems. Calibration and certification equipment traceable to national standards include reference standards for O_3, SO_2, H_2S, NO_x, and CO; flow calibrators; meteorological calibrators; and other operational support systems. ARS also maintains a full range of computer processing, analysis, graphics, and database capabilities to support data collection, validation, processing, archiving, and reporting.

ARS' staff has specific expertise in:

- Monitoring and analysis plans.
- Monitoring network management.
- Site selection and evaluation.
- Site preparation for access and utilities.
- Design, fabrication, and turnkey installation services for ambient air quality and meteorological monitoring systems.
- Instrument acceptance testing.
- Custom fabrication of monitoring and calibration support systems.
- Continuous ambient gas analyzers.
- TSP, PM_{10}, $PM_{2.5}$, and fine particles.
- Continuous particle sulfate and nitrate analyzers.
- Air toxics monitors.
- Brewer Spectrophotometers.
- Atmospheric deposition samplers.
- PSD, research, and tall-tower multilevel meteorological systems.
- Acoustic radar, SODAR, and radiosonde meteorological monitoring systems.
- Micrometeorological monitoring systems.
- AWOS system installation, maintenance, and FAA verification by certified personnel.
- Operational field and laboratory maintenance and calibration of network stations.
- Remote monitoring systems.

- Systems and performance audits and quality assurance services.
- Operational protocols, standard operating procedures, technical instruction, and quality assurance project plan (QAPP) preparation.
- Operator training and support.
- Operational data collection, reduction, validation, and review via telephone modem, satellite DCP, radio links, data storage modules, strip charts, or other media.
- Database development and management and data archive services.
- Integration of monitoring results with modeling application.
- Custom analytical, graphics, and presentation services including CD-ROM and video training program preparation.
- Application of statistical programs and other analytical tools to evaluate and compare monitored parameters.
- Comprehensive computer programming, processing, analyses, graphics, database, and Internet capabilities related to ambient air quality and meteorology data collection, validation, processing, archiving, quality assurance, and reporting.
- Comprehensive reports and presentations.
- Chain of custody accounting.

ARS maintains close working relationships with ambient air quality and meteorological instrument manufacturers, suppliers, and analytical laboratories in order to meet the needs of its clients.

Table B-1

Ambient Criteria, Meteorology, and Related Pollutant Monitoring
Instrumentation or Analysis Technique Experience
Air Resource Specialists, Inc.

Category	Parameter	Instrumentation or Analysis Technique
Ambient Gases	Ozone Oxides of Nitrogen (NO_2, NO_x, NO_y, NO_4) Sulfur Dioxide Hydrogen Sulfide Carbon Monoxide Carbon Dioxide Calibration Standards Ammonia	• Thermo Environmental (TECO) • Dasibi Environmental • Monitor Labs • Columbia Scientific • Advanced Pollution Instruments (API)
Particulates	TSP PM_{10} Fine (<$PM_{2.5}$) Atmospheric Deposition Systems Fine Particulate Speciation Systems	• Graseby Anderson, GMWL-200H Accu-VO1 • General Metal Works Accu-VO1 Model 1200 • IMPROVE Aerosol Sampler • Rupprecht and Patashnick (TEOM) • Stacked filter systems including • CASTNet systems • Dichotomous samplers • TECO DataRAM • Met One BAM, E-BAM, E-Sampler • CASTNet and NADP systems • FRM samplers (various manufacturers) • Aerosol speciation samplers (various manufacturers) • Size-differentiated drum samplers • Continuous sulfate and nitrate analyzers • Speciated continuous carbon analyzers
Meteorology (portable, 10-meter, and tall-tower)	Wind Speed/Wind Direction Temperature and Delta Temperature Relative Humidity Precipitation Solar Radiation Net Radiation Ultraviolet Radiation Wetness Micrometeorological Measurements Barometric Pressure Soil temperature and moisture Fuel temperature and moisture Soil heat flex Evaporation	• Climatronics • R. M. Young • Qualimetrics • Met One • Meteorology Research Inc. (MRI) • Rotronics • Vaisala • Coastal Environment • Brewer • Yankee

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Table B-1 (Continued)

Ambient Criteria, Meteorology, and Related Pollutant Monitoring
Instrumentation or Analysis Technique Experience
Air Resource Specialists, Inc.

Category	Parameter	Instrumentation or Analysis Technique
Meteorology (remote sensing)	Monostatic Acoustic Radar Phased-Array Doppler SODAR Radiosonde Measurement Systems	• AeroVironment • Radian • Vaisala
Data Acquisition Systems	Analog, digital, and event recording Digital output for monitoring station control Vector and sigma theta wind calculation	• Campbell Scientific • ESC • Odessa • Environmental Monitoring Co., Inc. • SumX • Vaisala • Coastal Environment • Others
Hazardous Airborne Contaminants	Combustibles or organic vapors	• MSA Combustible Gas Indicators (CGI) • MSA Photo-Ionization Detectors (PID) • HNu PID • OVA Flame Ionization Detector (FID)
Toxic Organic Compounds	Volatile Organic Compounds (VOCs)	• EPA TO-14 (SUMMA Canister) GC/MS
	Pesticides	• EPA TO-13 (PUF with glass fiber filter) GC/MS-SIM
	Polynuclear aromatic hydrocarbons (PAHs)	• EPA TO-13 modified CARB 429 (PUF with glass fiber filter) GC/MS
	Dioxins (Isomer specific)	• EPA TO-9 high resolution (PUF with glass fiber filter) GC/MS
	Metals:	
	Most Metals	• Method 6010 (quartz filter) ICP,
	Arsenic	• GMWL-2000A Accu-VO1
	Lead	• Method 7060 (quartz filter) GFAA
	Mercury	• Method 7421 (quartz filter) GFAA
	Selenium	• Method 7471 (quartz filter) CUAA,
	Thallium	• GMW VOTA Model 224 • Method 7740 (quartz filter) GFAA • Method 7841 (quartz filter) GFAA
Spectrophotometers	Columnar concentrations of atmospheric gases	• SCI-Tech Brewer Spectrophotometer

Visibility Monitoring, Data Analysis, Research, and Instrument Services

ARS has nationally recognized expertise in visibility monitoring, modeling, analysis, and research. ARS maintains visibility monitoring networks and has performed special studies for federal land management agencies, state agencies, municipalities, Indian nations, and private industry. ARS currently supports over 50 visibility monitoring sites nationwide and is the prime contractor to the IMPROVE Program, and U.S. Forest Service and National Park Service Visibility Monitoring and Data Analysis Programs. ARS' expertise includes:

- Design, installation, operation, and maintenance of operational visibility monitoring instrumentation, including nephelometers, transmissometers, aethalometers, single-frame and time-lapse cameras, digital cameras, video systems, fine particulate monitors, and meteorological sensors. ARS has special expertise in the implementation of remote monitoring systems.
- Design, implementation, and coordination of major visibility special studies and field programs, including: WHITEX, Denver Brown Cloud, Southern Utah Intensive, Phoenix/Tucson Urban Haze, PREVENT, MOHAVE, SEAVS, GRAVS, Dallas/Fort Worth Visibility Study, the Mount Zirkel Reasonable Attribution Study of Visibility Impairment, the Northern Front Range Air Quality Study, ACE-2, and BRAVO.
- Network operation, data analysis, reporting, training, and presentations.
- Theoretical development and application of visibility measurement and analysis procedures, including transmissometry and nephelometry, radiative transfer modeling, scientifically valid computer image simulations of visibility impairment, visual perception models, and extinction budget and cause-effect analyses.
- Innovative development and operational application of remote single-frame and time-lapse photographic and video monitoring systems and of remote digital camera systems.
- Development and implementation of Web-based digital image and associated data acquisition and display systems including Web site design and hosting.
- Development of interpretive displays including static, video, and digital media.
- Camera and video source surveillance to document the dynamics of urban hazes and individual source emissions. Results, particularly time-lapse images, are used for model parameter evaluation, model verification, operations documentation, and source attribution.
- Development and testing of visibility monitoring systems. In cooperation with federal land management agencies and instrument manufacturers, ARS has conducted field trials and contributed to the design and evolution of transmissometers, ambient and size-cut nephelometers, and photographic film, digital, and video monitoring systems.
- Development of Historical Image Archives procedures and compilation of image archives for over 60 federal land management agency monitoring sites.
- Development of IMPROVE Protocol standard operating procedures and technical

instructions for optical, scene, and support systems monitoring, data handling, and reporting.

- Fabrication of instrumentation and support systems, including custom circuit boards, instrument shelters, unique calibration and test equipment, power systems, shipping systems, and data telemetry systems.
- Maintenance and calibration services for all types of optical and scene visibility monitoring instrumentation.
- A full range of computer programming, processing, analysis, graphics, database, and Internet capabilities related to visibility data collection, validation, processing, archiving, and reporting.

Professional working relationships with visibility-related instrument and analytical services experts enhance the corporation's ability to provide the highest quality services.

Visibility Modeling

Staff scientists are involved in the development and implementation of visibility air quality-related computer modeling techniques, including the following:

- Visibility-related radiative transfer modeling.
- Computer image simulation of visibility degradation.
- Visual perception models.
- Model comparison, testing, and evaluation.
- Model installation, modification, documentation, and training.
- Algorithm development.

ARS has been an integral developer of the NPS-sponsored WinHaze program used extensively to generate image simulations of visibility degradation. Visibility modeling has been applied to support congressional hearings, special studies, and a broad range of regulatory, research, and experimental applications.

Table B-2

Visibility-Related Monitoring Instrumentation Experience
Air Resource Specialists, Inc.

Category	Parameter	Instrumentation
Optical	Extinction	• Optec LPV-2 transmissometers • Teleradiometers • Slide scanning densitometry
	Scattering	• Optec NGN-2 ambient and NGN-3 size-cut nephelometers • Radiance Research nephelometers • TSI nephelometers • Belfort-type nephelometers • Infrared nephelometers/particle samplers • Laser photometers
	Absorption	• TECO aethalometer • Filter-based absorption method
Scene	35 mm still-frame Digital still-frame and Web-based digital camera systems	• Full range of 35 mm film SLR based automatic systems • Fully automated, and remotely accessible digital camera systems including direct Internet access • Complete remote monitoring system fabrication for specific source surveillance or regional documentation
	8 mm time-lapse	• Minolta-based 8 mm film integrated time-lapse systems • Complete remote monitoring system fabrication • 8 mm to video transfer
	Time-lapse video	• Simple to fully automated time-lapse video systems including remote system fabrication
	Photographic, video, and CD-ROM presentations	• Development of photographic, video, and CD-ROM presentations including interpretive displays and Web sites including Web site hosting
	Image archives	• Film storage • Image digitization • CD-ROM applications
Aerosol	Fine particles	• IMPROVE modular aerosol sampler (I and II) • Stacked filter systems • Size differentiated drum samplers • Dichotomous and TEOM samplers • MIE, Inc. DataRAM • TSI DUSTTRAK • MetOne GT-640 • AirMetrics MiniVol • Streaker samplers • Continuous particle sulfate and nitrate analyzers

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Table B-2 (Continued)

Visibility-Related Monitoring Instrumentation Experience
Air Resource Specialists, Inc.

Category	Parameter	Instrumentation
Meteorology	Ambient temperature/relative humidity	• Rotronics, Met One, Vaisala, Climatronics, RM Young • Digilog Vaportron H-100L Calibrator
	Wind speed/wind direction	• Met One, Climatronics, Qualimetrics, Vaisala, RM Young
Data Acquisition Systems	Programmable smart loggers for analog, digital, and event recording	• Campbell Scientific 23X, 21XL, and CR10 systems and all Campbell systems • Vaisala (Handar) and Synergetics DCPs • Fabrication of integrated datalogging and control subsystems • Remote radio, satellite, and cellular telephone data transmission
	Strip chart recorders	• Yokogawa and other analog and digital strip chart manufacturers
Power Systems	Remote solar systems	• Kyocera and other panel manufacturers • Fabrication and integration of complete solar systems for remote applications
	Line power	• Fabrication and integration of line-powered monitoring support and climate control systems

Air Quality Modeling, Permitting, and Compliance Services

ARS staff scientists provide comprehensive air modeling, permitting, and compliance support to industrial, commercial, and government clients through its Environmental Compliance Section. ARS professionals help regulated facilities identify permitting needs and stay in compliance with the constantly evolving requirements of the Clean Air Act and state/local regulations. Professional and cost-effective technical and regulatory support includes:

- Air quality construction and operating permits and permit compliance assistance.
  - Defining applicable and non-applicable regulations.
  - Quantifying emissions.
  - Dispersion modeling and impact assessment.
  - Selecting appropriate emissions abatement practices.
  - Negotiating permit language.
  - Recommending and implementing strategies for ongoing compliance monitoring.

- Emissions inventories.
  - Calculating industrial and commercial emission rates for common industrial sources as well as complex sources such as fugitive dust from roads and organic emissions from wastewater treatment systems.
  - Developing facility-specific emission calculation spreadsheets along with instruction on their use, allowing clients to become more self-sufficient on future emission inventories and inventory reporting.

- Air Quality and Noise Modeling.
  - Air quality modeling of stationary and mobile emission sources to determine compliance with National Ambient Air Quality Standards (NAAQS), PSD increment limits, and other regulatory requirements. Modeling expertise including EPA air quality models, as well as specialized models for addressing unique situations, such as dispersion in complex terrain, accidental releases of hazardous materials, highway and transportation sources, impacts to Air Quality Related Values such as visibility degradation and acid deposition, and comprehensive regional scale modeling studies.
  - Performing air quality technical studies and analyses for compliance with the National Environmental Policy Act (NEPA), preparation of Environmental Impact Statements (EISs) and other NEPA compliance documents.
  - Preparing Section 112r Risk Management Plans.
  - Reviewing and evaluating new and modified air emission sources with respect to applicability of New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD), Non-Attainment area permitting requirements, and other federal and state regulatory requirements.
  - Performing noise modeling for highways, railroads, airports, construction activities, and industry. Assisting with noise monitoring, mitigation, and noise reduction strategies.

- Compliance Audits and Compliance Assistance.
  - Performing independent and confidential assessments of air compliance.
  - Preparing clear concise briefings and reports that identify compliance requirements and list recommendations.
  - Providing convenient checklists that identify permit and regulatory requirements and related compliance actions to allow clients to efficiently manage their day-to-day environmental compliance activities.

ARS staff is knowledgeable about many industries, but has developed particular expertise on issues affecting industries in the western United States including: mining and minerals, oil and natural gas processing and transmission, metals (aluminum, steel, copper, etc.) electronics, agricultural products (ethanol, sugar, etc.), airports and transportation, regional scale air quality studies, and municipal operations.

B.1.1 Air Quality Laboratory

Ambient Monitoring Instrumentation

ARS maintains a fully equipped air quality laboratory with diagnostic tools and support equipment to acceptance test, certify, calibrate, and repair ambient air quality and meteorological instrumentation, dataloggers, and electronic and mechanical support systems. Calibration and certification equipment traceable to national standards assures accurate and repeatable results. Specific equipment services include:

- Ozone primary standard verification and transfer standard certification with a laboratory ozone photometer.
- Repair and calibration of O_3, NO_x, SO_2, H_2S, CO, and CO_2 analyzers with certified gas cylinders.
- Fabrication and repair of specialized calibration and zero air systems utilizing laboratory primary flow standards.
- Calibration of high-volume, PM_{10}, and fine particulate samplers with certified flow measurement calibrators.
- Repair and rebuilding of meteorological monitoring instrumentation and calibration with NIST-traceable standards for barometric pressure, temperature, humidity, and precipitation, and reference standards for wind speed, wind direction, and solar radiation.
- Fabrication, repair, and customization of electrical and electronic control and monitoring support subsystems.

A full complement of tools, diagnostic equipment, and manuals, as well as an inventory of spare parts and supplies, are maintained to support troubleshooting, repair, refurbishing, and fabrication of monitoring instruments, datalogging systems, and support systems.

Audit Instrumentation

ARS maintains complete sets of instrumentation dedicated to independent field performance audits. This equipment is maintained to calibration standards traceable to the National Institute of Standards and Technology (NIST) and is used exclusively for performance audits. Audit instrumentation includes:

- Voltage reference and measurement sources.
- Pulsed low torque motors for anemometer testing.
- Torque discs and torque gauges to measure wind shaft starting thresholds.
- Mercury-in-glass thermometers and psychrometers.
- In-field portable humidity chambers
- Eppley solar radiometers.
- Precipitation measurement volumes and standards.
- Certified flow measurement calibrators for particulate samplers and other flow-specific instrumentation.
- Laboratory certified (EPA Protocol 2) pollutant gas cylinders.
- Mass flow controlled gas dilution/titration calibration boxes.
- Portable zero air supplies.
- TECO portable ozone primary photometer.
- Portable data logging systems for audit data capture.
- Laptop computers with computer based audit forms and Internet and e-mail access.

ARS has designed wind instrument audit/calibration jigs for all common meteorological instrumentation. These jigs provide secure and accurate placement of indexed linearity fixtures, tachometer motors, torque gauges, and alignment devices to ensure accurate auditing of tower mounted wind instrumentation.

Audit reporting formats have been automated to allow linking of performance audit data, monitoring station specifications, and written observations into Windows-compatible report files. ARS field specialists enter audit data into Excel spreadsheets at the monitoring station for efficient and accurate reporting. Preliminary audit results are left on-site, providing the station operator with an immediate indication of instrument performance and can be e-mailed directly to project coordinators. Full audit reports are expediently prepared and delivered.

B.1.2 Visibility Laboratory

Visibility Monitoring Instrumentation

A fully equipped laboratory at ARS provides electronic, optic, and mechanical systems support to both research and operational visibility monitoring programs. ARS scientists and technicians are experienced with state-of-the-art instrumentation and have developed and received specialized training in techniques and procedures unique to the complexities associated with the measurement of light and the maintenance and calibration of visibility monitoring equipment. The ARS visibility laboratory is also a factory-authorized repair facility for Optec nephelometers and transmissometers. Laboratory instrumentation includes:

- High-resolution, digital multimeters.
- Frequency counters.
- Waveform generators.
- Laboratory-grade power supplies.
- 20 MHz dual channel oscilloscope.
- Instrument-specific calibration and test equipment.
- Dataloggers and recorders.
- Spare parts and component inventories.

Equipment specifically required to service and calibrate transmissometer optics includes an Oriel optical bench with a selection of filters, mounts, holders, and light sources. ARS also has established working relationships with factory-authorized camera and video repair facilities.

National Visibility Scene Archives

ARS maintains the NPS, USFS, BLM, IMPROVE, EPA, CASTNet, and numerous state visibility scene archives. These national archives consist of over 500,000 visibility slides taken since 1979 at monitoring sites throughout the United States. All slides are catalogued and filed for convenient user access to support visibility-related research, presentations, and other applications. Selected slide series from individual sites, referred to as site spectrums, are also compiled, digitized, and maintained on CD-ROM. Image series collected directly by digital cameras are maintained in an image database and on archive CD-ROMs.

Slide Scanning System

ARS maintains a 35mm color slide scanning system based on a Nikon Coolscan scanner, Pentium PC, Windows operating system, and scanning and analytical software. The system can be applied to digitize entire slides or to extract specific density measurements.

Field Calibration and Test Facility

ARS designed, fabricated, installed, and operates a dedicated field calibration and test facility configured for instrument calibrations and a wide range of instrument operations and comparison tests. The facility allows for both point and path tests and calibrations. On-site instrumentation includes dataloggers, a tracking transmissometer (for side-by-side comparisons), an ambient nephelometer, meteorological towers and equipment, electronic test equipment, and other support systems. The facility allows careful, comprehensive nephelometer and transmissometer calibrations which are critical to ensure accurate quality-assured visibility data.

B.1.3 Shop Facilities

ARS maintains a full electronic and maintenance shop on-site to facilitate the construction and fabrication of instrumentation and support equipment, including custom circuit boards, instrument shelters, unique calibration and test fixtures, remote camera systems, power systems, support structures, and hardware, cables, etc. The shop also provides on-site capabilities for indoor and outdoor system testing and staging for field operations. An array of electronic, woodworking, and machine tools are maintained in the shop, and all field personnel are provided with a complete set of field service tools and diagnostic test equipment.

On-site capabilities are supplemented by arrangements with independent contractors and suppliers, including metal fabricating, precision machining, shelter manufacturing, electrical and electronic supply, manufacturer-specific replacement parts, and other expert services.

B.1.4 Computer Facilities

ARS maintains an extensive microcomputer-based processing facility centered around a Novell NetWare 5.1 network operating system. The network has over 40 workstations with Pentium I, II, and III microprocessors running on MS Windows 95, Windows 98, Windows 2000 Professional, or Windows NT 4.0 workstations. The workstations access six file servers with 118 gigabytes of on-line disk storage capacity. Files are secured by daily, weekly, and monthly full-disk backups on high-capacity 4 mm DDS4Dat cassette tapes and high capacity DLT tapes. In addition, raw and processed data are maintained on dual-copy, off-site archives.

Data communications are managed with a T1 line for Internet access, high-speed modems, and a variety of commercial communications software. Data communications are extensively employed in the following areas:

- Internet, FTP, e-mail, and utility services are maintained on a high speed, dedicated 1544 kb/s T1 data line supported by a Tier 1 Internet Service Provider
- Automatic and manual data collection from a variety of dataloggers
- Access to other computer facilities

Printer and high-resolution graphics outputs are generated with LaserJet Series 4 and Series 4000 printers. Color printing/plotting is available with an Epson Color 800 Stylus printer and a HP Color LaserJet 4500N. Map production is accomplished with a variety of hardware, software, and on-line data sources. Hewlett-Packard Scanjet 6100C and Polaroid SprintScan 35LE systems permit scanning of hardcopy photographs and other images at up to 2700 dpi for high quality report preparation.

In addition, ARS maintains an extensive library of the following commercial and in-house software:

- Financial accounting and management
- Word processing
- Desktop publishing
- Modem communications
- Data compilation
- Database management
- Statistical data analysis
- Image-processing
- Mapping
- Scientific information presentation and graphics production
- Circuit board design
- Meteorology and air quality modeling

System capabilities include the ability to write or read to many types of digital storage media including:

- Industry standard CD-ROM disks.
- PC-compatible diskettes of any standard size or density.
- QIC technology cartridge streamer tapes written with Colorado Trakker and Iomega tape drives.
- Iomega zip drives.
- 4 mm DAT cassettes with capacities of 24 gigabytes and 40 gigabytes written with HP Surestore (DDS3 and DDS4 formats).
- DLT Tape format with HP Surestore DLT1 80 gigabyte capacity drive.

B.1.5 Information Management Center

The ARS Information Management Center (IMC) is a centralized data management center that includes all of the hardware, software, databases, communications, facilities, and support systems required to efficiently and effectively manage all data for environmental

monitoring networks. The IMC is applied by ARS to collect, validate, analyze, report, archive, and distribute air quality, visibility, meteorology, and supporting data for a variety of contract efforts.

A primary component of the IMC is the Air Quality DataBase Management System (AQDBMS), a collection of air quality-related databases and data processing and communications applications. This comprehensive, PC-based, state-of-the-art system is used to handle all data from a variety of monitoring networks in a way that ensures the highest quality, quantity, and security of the data.