LEO DROZDOFF, *Administrator*

(775) 687-4670
Administration
Facsimile 687-5856

Water Quality Planning
Water Pollution Control
Facsimile 687-4684
Safe Drinking Water
Facsimile 687-5699

Mining Regulation & Reclamation
Facsimile 684-5259

State of Nevada
KENNY C. GUINN
Governor

ALLEN BIAGGI, *Director*

Air Pollution Control
Air Quality Planning
Facsimile 687-6396

Waste Management
Federal Facilities

Corrective Actions
Facsimile 687-8335

NDEP.nv.gov

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL PROTECTION

901 South Stewart Street, Suite 4001
Carson City, Nevada 89701-5249

August 18, 2005

Michael N. Jones (D243-02)
EMAD/AAMG
Research Triangle Park, NC 27711

Dear Mr. Jones:

Enclosed is the Nevada Division of Environmental Protection's (NDEP) application for the Local-Scale Air Toxics Ambient Monitoring Grant. The funds will be used in collaboration with the University of Nevada-Reno and Frontier Geosciences for development of broadly deployable methods for quantifying atmospheric Hg speciation in urban and rural settings in Nevada.

Please contact me at (775) 687-9329 if you have any questions or concerns regarding this application.

Sincerely

Michael Elges
Chief
Bureau of Air Pollution Control

ME/vg

cc: Colleen Cripps, Ph.D., NDEP (w/enc)
Jennifer Carr, NDEP (w/enc)

Version 7/03

APPLICATION FOR FEDERAL ASSISTANCE

2. DATE SUBMITTED		Applicant Identifier
1. TYPE OF SUBMISSION: Application: ☐ Construction ☒ Non-Construction; Pre-application: ☐ Construction ☐ Non-Construction	3. DATE RECEIVED BY STATE	State Application Identifier
	4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

5. APPLICANT INFORMATION

Legal Name: **State of Nevada**	Organizational Unit: Department: **Department of Conservation and Natural Resources**
Organizational DUNS: **093819998**	Division: **Division of Environmental Protection**
Address:	Name and telephone number of person to be contacted on matters involving this application (give area code)
Street: **901 South Stewart Street, Room 4001**	Prefix: **Mr.** First Name: **Michael**
City: **Carson City**	Middle Name: **James**
County: **Carson City**	Last Name: **Elges**
State: **Nevada** Zip Code: **89701-5249**	Suffix:
Country: **United States of America**	Email: **melges@ndep.nv.gov**
6. EMPLOYER IDENTIFICATION NUMBER (EIN): 88-6000022	Phone Number (give area code): **(775) 687-9329** Fax Number (give area code): **(775) 687-6396**
8. TYPE OF APPLICATION: ☒ New ☐ Continuation ☐ Revision. If Revision, enter appropriate letter(s) in box(es) (See back of form for description of letters.) ☐ ☐ Other (specify)	7. TYPE OF APPLICANT: (See back of form for Application Types) **A. State** Other (specify)
	9. NAME OF FEDERAL AGENCY:
10 CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: 66-034. TITLE (Name of Program): **Local-Scale Air Toxics Ambient Monitoring**	11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: **Development of broadly deployable methods for quantifying atmospheric Hg speciation in urban and rural settings in Nevada.**
12. AREAS AFFECTED BY PROJECT (Cities, Counties, States, etc): **State of Nevada**	
13. PROPOSED PROJECT: Start Date: 10/01/2005 Ending Date: 10/01/2007	14. CONGRESSIONAL DISTRICTS OF: a. Applicant b. Project

15. ESTIMATED FUNDING:	
a. Federal	$ 363,890
b. Applicant	$ 50,000
c. State	$
d. Local	$
e. Other **See 2.e. on work plan**	$ 168,686
f. Program Income	$
g. TOTAL	$ 582,576

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. Yes ☐ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON DATE:

b. No ☐ PROGRAM IS NOT COVERED BY E. O. 12372 ☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT? ☐ Yes If "Yes" attach an explanation. ☒ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT. THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Authorized Representative		
Prefix **Mr.**	First Name **Leo**	Middle Name
Last Name **Drozdoff**		Suffix
b. Title **Administrator**		c. Telephone Number (give area code) **(775) 687-9301**
d. Signature of Authorized Representative: Doug Zimmerman for Leo Drozdoff		e. Date Signed 8/18/05

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Standard Form 424 (Rev. 9-2003)
Prescribed by OMB Circular A-102

1. SF-424
See attached.

2. **Narrative Workplan:**

a. ***Project Title:*** "Development of broadly deployable methods for quantifying atmospheric Hg speciation in urban and rural settings in Nevada"

b. ***Category:*** Methods Development

c. ***Applicant information:***

The State contacts, Nevada Division of Environmental Protection, for this proposal will be:

Colleen Cripps, Ph.D. Deputy Administrator Nevada Division of Environmental Protection Carson City, NV 89706 (775) 687-9302 cripps@ndep.nv.gov

Mike Elges Chief Bureau of Air Pollution Control Nevada Division of Environmental Protection Carson City, NV 89706 (775) 687-9329 melges@ndep.nv.gov

The project is in collaboration with the **University of Nevada-Reno and Frontier Geosciences**:

Dr. Mae Gustin, Associate Professor, Department of Natural Resources and Environmental Sciences MS370 University of Nevada-Reno, Reno, NV 89557 (775) 784-4203 msg@unr.nevada.edu web page www.cabnr.unr.edu/gustin

Dr. Eric Prestbo, Frontier Geosciences, Senior Research Scientist 414 Pontius Avenue North Seattle, WA 98109 206-622-6960 ericp@fontiergeosciences.com web page: www.frontiergeosciences.com

d. ***Funding Requested:***

$246,980 for UNR
$ 30,910 National Atmospheric Deposition Network
$ 86,000 Frontier Geosciences
$363,890 TOTAL REQUESTED

e. ***Total project cost:*** Project funding requested plus cost share

$335,666-UNR
$ 30,910-National Atmospheric Deposition Network
$106,000-Frontier
$ 50,000-NDEP
$ 40,000-Continued support of MDN sites
$ 20,000-Loan of equipment EPA Region 9
$582,576-TOTAL PROJECT COST

Description of in-kind resources and cost share

1). Mae Gustin at **UNR** currently has limited funding from USDA-UNR College of Agriculture-HATCH grant program that is paying a graduate student (Seth Lyman) to begin to collect preliminary data on mercury (Hg) speciation in air and develop some insight regarding dry deposition of Hg in Reno and at two national Mercury Deposition

Network sites in Nevada. This ongoing effort is in collaboration with Frontier Geosciences, EPA Region 9, Oak Ridge National Laboratory, Lesperance and Gibbs ranch owners and Desert Research Institute. Atmospheric Hg species, including elemental Hg, reactive gaseous Hg and particulate Hg concentrations in air are being measured at three sites. A field protocol for use of ion exchange membranes for collecting atmospheric Hg is being developed and they are being tested in the field. *This project provides important preliminary data for method development that will directly support this project and significantly reduce start up time. In addition work being done on this current project will provide significant direction for focusing lab and field studies described in this project.* Funding for this project will continue until June 2007 and will be used to support one of the two graduate students working on the project. In addition, a month of Dr. Gustin's salary will be cost shared each year by CABNR. The UNR overhead rate applied for NDEP funded UNR projects is 26%, which is also a cost share for the UNR overhead rate which is usually 45%.

2). Significant collaborations have been built during the ongoing project described above with the **Lesperance and Gibbs ranch owners** where national Mercury Deposition Network (MDN) wet deposition samplers are located; **Desert Research Institute** (DRI) where we are monitoring air Hg speciation in Reno, adjacent to a NOAA micrometeorological station, and **EPA Region 9** (who has lent us an air Hg speciation system). These collaborations will most likely continue for this project.

3). **EPA** has tentatively agreed to continue to support the MDN sites located at the Lesperance and Gibbs ranches in rural Nevada. These sites will be used for field testing passive samplers, measuring atmospheric speciation and trying to quantify dry deposition. Collection of data at these two sites will allow us to compare the concentration and speciation of Hg at a rural versus urban site, better understand the significance of dry versus wet deposition of atmospheric Hg and compare data collected upwind and downwind of naturally enriched areas and potential anthropogenic sources.

4). **NDEP** will help with support providing available sulfur dioxide (SO_2), nitrogen oxide (NOx) and ozone analyzers for use during assessment of passive sampling methods as well as to use for potential identification of anthropogenic Hg sources. NDEP will also provide support staff to help with field deployment of passive samplers in the latter part of the project. They also will manage monthly reports, budgets and project oversight and these costs are cost shared by the agency.

f. ***Project period:*** October 2005 to October 2007

g. ***Explicit description:***

1). **Project summary**

The largest anthropogenic sources of mercury (Hg) to the atmosphere in Nevada are gold and silver ore processing facilities. In addition, the state is home to large areas of natural geologic Hg enrichment that are a significant source of atmospheric Hg (Zehner and Gustin, 2002). Other potential sources of Hg to the atmosphere in the state are geothermal areas, and geothermal and coal combustion based energy production. Since much of the geothermal energy production in the state applies binary recover systems, emissions from this source are likely to be small. To better understand the significance of these sources with respect to impacts locally and regionally, and to begin to assess the significance of dry versus wet deposition of Hg, the Nevada Division of Environmental Protection will partner with Dr. Mae Gustin-Associate Professor at the University of Nevada, and Dr. Eric Prestbo-Senior Research Scientist with Frontier Geosciences, Inc. The primary research goal of this project is to develop an easily deployable sampling system that may be used to characterize total atmospheric Hg and reactive gaseous Hg concentrations. The focus will be development of a system that may eventually be applied at a national level for ambient Hg monitoring. As part of this project we also will develop important information on the potential for dry deposition of Hg in western ecosystems at one location.

The major forms of Hg in the air are elemental Hg (>95%), reactive gaseous Hg (RGM) and particulate Hg. The project will consist of 1) laboratory testing of field deployable methods for measurement of total and reactive Hg in air; 2) field testing of the methods developed simultaneously with the measurement of Hg speciation in air using currently applied automated samplers linked to a cold vapor atomic fluorescence Hg analyzer (Tekran 2537A mercury analyzer, 1130 RGM collection system and 1135 particulate Hg sampler) and micrometeorological parameters and other routinely monitored ambient air quality parameters (nitrogen oxides (NOx), sulfur dioxide (SO_2) with automated and passive samplers, and Ozone) to investigate potential anthropogenic sources and 3) testing of passive samplers through regular field deployment at national Mercury Deposition Network (MDN) sites in Nevada, at a National Park Service air quality monitoring site, and in transects down wind of a coal-fired power plant, an ore-processing facility and a naturally Hg-enriched area. This last objective will allow us to test whether protocols developed in this project are easily followed; and to investigate whether the passive sampling system developed may be applied to see if there are elevated atmospheric Hg concentrations directly downwind of emission sources.

This project focuses on development of a passive sampling system for measurement of total and reactive gaseous Hg in ambient air. Mercury is currently an air toxic issue of significant local, regional and national interest. However, there is currently no easily deployed ambient measurement system for quantifying total Hg in air. In addition, our understanding of the significance of dry deposition versus wet deposition of this toxin is very poor and significantly more information is needed. Currently regulations are being applied for coal-fired utility Hg emissions yet there is no system in place to effectively assess their impact locally and regionally and no means of assessing effectiveness of regulations (cf. Mason et al., 2005).

<u>Detailed project summary</u>

Atmospheric deposition of mercury (Hg) is considered to be a major pathway for Hg to enter terrestrial and aquatic ecosystems (Swain et al., 1992; Mason et al., 2000; Schroeder et al., 1998). Both wet and dry deposition is known to occur, however the latter cannot yet be measured with an easily deployed and self-maintaining system. Some researchers (Seigneur et al., 2001; Kamman and Engstrom, 2002) have suggested that dry deposition is a significant input of Hg to ecosystems and is more important in arid ecosystems were precipitation amounts are low. As part of the National Atmospheric Deposition Network (http://nadp.sws.uiuc.edu), established to monitor acid rain, a national Mercury Deposition Network (MDN) has been established (http://nadp.sws.uiuc.edu/mdn/sites.asp). MDN sites are fully automated to collect only wet deposition. There are very few MDN sites in the west (1 NM, 2 NV, 2 CA, 2CO, 1 WY, 2WA out of ~60 locations in the United States) and only at the New Mexico site has any attempt been made to measure dry deposition. However, no work has been published from this limited research and our understanding of the significance of dry deposition is very poor.

In order to determine dry deposition of mercury we must be able to measure atmospheric Hg speciation. Reactive forms of Hg are thought to have the highest deposition velocity, although recent work has shown that deposition of elemental Hg is also important (Ericksen et al., 2005). Currently measurement of mercury speciation in air can only be done using very expensive (~$100,000) sensitive equipment, which requires technically trained personnel to operate and maintain (Tekran 2537A Hg analyzer linked to a Tekran 1130 reactive gaseous mercury denuder system and 1135 particulate mercury collection unit). Because of cost and trained personnel needed to operate this system, state agencies do not have this capability for investigating air Hg concentrations, local and regional issues regarding Hg inputs, and impacts of sources in their jurisdiction.

The major objective of this project is to develop a passive sampling system to determine Hg speciation in air that is easily deployable. This will require laboratory and field-testing as described below. We will focus on development of a system to measure total Hg in air and reactive Hg. During this project we will measure a variety of parameters in the field that will allow us to determine the potential for the passive sampling system to give some indication of dry deposition of Hg as well as to potentially identify the source. This project will also collect data that will advance our understanding of some major research questions in terms of the biogeochemical cycle of Hg:
-Can we do any sort of source apportionment by measuring atmospheric speciation and using passive sampling systems?
-How does Hg speciation in urban air compare with that of air at remote sites and those downwind of known anthropogenic sources?
-How significant is dry deposition of Hg relative to wet deposition especially in arid systems?
-Is the dry deposition of elemental Hg more significant than reactive gaseous Hg or particulate Hg since it is the dominant form in the atmosphere (>95%)?

<u>Objectives</u>
Overall objective: Development of an easily deployable and affordable system for quantifying Hg concentration and speciation in the air.

I. Laboratory development and testing of effectiveness of passive samplers (Year 1)

II. Use the Tekran Hg air speciation system and measurement other ancillary parameters to assess the performance of passive samplers in urban and rural field settings (Year 1 to 1.5 with Objective 1 and 2 worked on simultaneously to compliment each other).

III. Test passive samplers use through deployment at MDN and at least one National Park Service ambient air quality monitoring site, and downwind of known emission sources of Hg (Year 2).

The major objective of this project is to develop ambient monitoring methods that may be applied for characterizing and quantifying atmospheric Hg speciation and to critically assess the potential for these samplers to give some indication of dry deposition of Hg. We hope to develop using easily deployable passive samplers that may be distributed over a broad area and integrated into the MDN system. We will develop a method for deployment and use that will not require a high level of technical training and may be done based on a simple instructional protocol that is easy to follow.

This project will build off of the foundation of ongoing work at the University of Nevada-Reno that has begun to measure atmospheric mercury speciation and the potential for dry deposition of Hg using multiple methods including: the Tekran 2537 A/1130/1135 Hg speciation system, field flux chambers, surrogate surfaces, gradient measurements, and micrometeorological parameters in Reno and at two Mercury Deposition Network sites. For this project atmospheric Hg speciation (Elemental, Reactive and Particulate Mercury) is being measured with equipment made available from EPA Region 9 and Oak Ridge National Laboratory. Preliminary data regarding the use of polysulfone ion exchange membranes for measurement of reactive forms of Hg in air is being developed. Work has been done establishing the quality control handling procedures for these membranes during field deployment. Data is still being processed regarding the viability of their use in the field and based on data collected so far, laboratory testing needs to be done to better understand their use and the potential for Hg to be re-emitted once adsorbed to the surfaces. A better method for housing these membranes also needs to be developed. As part of this project we will test additional sorbents and do detailed laboratory work to better understand the use and limitations of the polysulfone filters and other sorbent materials and develop housing.

Additionally, the ion exchange membranes may not be applied for determining elemental Hg in air we will develop a method to do this. Preliminary screening of potential materials will be done at Frontier and then media characterization using the laboratory gas exchange system described below at UNR.

As part of this proposed project we would focus on developing a passive method that allows for characterization of total gaseous mercury in air as well as reactive Hg. Preliminary data developed so far as part of the College of Agriculture HATCH project will provide a strong foundation for doing a focused project. Using already collected field data we have an understanding of atmospheric concentrations of different Hg species that will be collected and necessary detection limits for ambient samplers as well as the Quality Control/Quality Assurance needed to apply the ambient passive sampling systems. For example, digestion of blank polysulfone filters was done to ensure we

deployed membranes for sufficient time to measure mercury uptake and several mounting mechanisms were applied. We have realized that for field deployment a different housing mechanism than currently used needs to be applied.
The first year of work will focus on laboratory development of sorbents at Frontier, mechanistic laboratory studies centered at UNR and field studies centered at the established DRI sampling station where we hope to install an additional MDN site. The second year will entail continued field validation and deployment of the samplers by those managing MDN and at one National Park Service air quality monitoring site in Nevada. We will also deploy samplers down wind of anthropogenic sources of Hg in Nevada to see if there is the potential for these sources to general local and regional hot spots of Hg deposition.

Objective 1. Laboratory studies.
Laboratory studies will focus on development of passive samplers that may be deployed for 7 days (similar to the length of time between sampling at the MDN sites) that will allow us to determine total atmospheric Hg and reactive Hg. The ion exchange polysulfone membrane described above needs significant laboratory validation of what they are collecting (that is elemental, reactive or particulate Hg) and the ability of the surface to retain Hg once deposited. We will test some additional sorbents and work on development of a method to integrate total gaseous Hg. Preliminary work will be done at Frontier on sorbent materials investigating their ability to absorb elemental Hg and gaseous reactive Hg from air. For laboratory characterization studies a single pass gas exchange chamber (there are two available) at UNR will be used. The UNR system has been successfully applied for years to investigate mercury and other trace gas exchange between soils, vegetation and the air (Gustin et al., 1999; 2002). This highly controlled experimental system can be applied to develop exposures to specific air chemistry (i.e. Hg concentration, speciation, oxidants, water content) and environmental conditions (light, temperature, air mass exposure). The volume of the exposure chamber is large enough to allow for multiple exposure scenarios simultaneously so that material, orientation, size, surface area and housing can be investigated during simultaneous exposures. Surfaces that may potentially be employed include gold or silver plated material with a large surface area, wax coated plates or Teflon surfaces. Different sorbents will be explored as needed in order to find a set of materials that best allows us to characterize total Hg and reactive Hg concentrations in air. A variety of surfaces may be applied for it may be that multiple surfaces will result in the best way to establish speciation. For example polysulfone filters used in tandem with others may be used to fine tune understanding of speciation. We will also test for the possibility of re-emission of Hg once adsorbed to the surface.

The capability to analyze all environmental media for Hg is available at the University of Nevada and Frontier Geosciences. For example, if gold surfaces are used thermal desorption may be the best means of quantifying Hg. Sorbents may be subjected to digestion and Hg quantification using Cold Vapor Fluorescence Hg detection. Analytical methods will be carefully tested and quality control procedures developed so that we build a standard protocol for measurement of Hg collected by sorbent materials. Analytical procedures have been developed at UNR for the polysulfone membranes. This information will be useful in driving future research directions and developing protocols for other materials. Sample analyses will be crosschecked between UNR and Frontier Geosciences for quality assurance.

Objective 2. Simultaneously with laboratory testing of materials they will be tested in the field.

To check the passive Hg sampling system performance we will deploy developed media in urban and rural settings and simultaneously measure air Hg speciation using the Tekran automated air speciation system. Membrane efficiency will be determined by comparing reactive gaseous Hg, particulate Hg and elemental Hg concentrations measured in air during deployment using Tekran 1130, 1135 and 2537A units, respectively. This will be done primarily at the Reno-DRI site due to proximity to the lab. Some testing will also be done using a Tekran 2537A Hg analyzer in Seattle at Frontier. This will give us data from two different climatic regimes. The Reno site is positioned adjacent to a NOAA weather station so meteorological data is also recorded continuously and available for use. Data on other atmospheric constituents (i.e. ozone, Nitrogen Oxides (NOx), sulfur dioxide (SO_2)) will also be collected either through collaboration with DRI or through use of equipment available from NDEP. As part of this project we will co-locate an additional MDN site at the Reno site to allow us to determine wet deposition of Hg at this site.

We will be collecting a significant amount of air speciation data as well as ancillary information over two years that will allow us to assess the potential for dry deposition at DRI. Dry deposition of elemental Hg will be directly measured using a field flux chamber; gradient measurements of elemental, reactive and particulate Hg using the Tekran speciation systems and additional Tekran 2537A analyzers and manual denuders (available at UNR) or Tekran 1130/1135 systems if available. Deployment of passive samplers at different heights will also allow us to assess gradients. This information will allow us to have multiple data sets that may be used to calculate deposition rates at one field site. Deposition rates can be checked based on published values.

In the field we will also deploy passive SOx samplers described by Lan et al. (2004) and used by IVL in Sweden (Ferm and Svanberg, 1998) to see if they can be used to investigate potential anthropogenic inputs of Hg and SOx to the area.

We plan to use the DRI site to help validate the passive sampling system in the field and then deploy at the closer Lesperance MDN site. If two Tekran air sampling systems are available we will also deploy at the Gibbs Ranch site. During the HATCH project we will have collected atmospheric Hg concentration data at both the Lesperance and Gibbs MDS sites in March 2005, and July 2005; and plan to sample in October 2005 and December 2005. We feel it is important to apply the passive sampling system at both rural and urban sites because the air will have different chemistry. Micrometeorological conditions including air temperature, wind velocity and direction, relative humidity and incident radiation will be averaged and recorded using a data logger during all field campaigns. We will apply the passive SOx filters and automated NOx, SOx and ozone analyzers when possible.

Objective 3. Field deployment of passive sampling system by MDN and NPS ambient air quality station operators and down wind of atmospheric Hg sources. The third component of this project consists of testing of developed passive samplers for total and reactive mercury through deployment and collection by operators of the MDN and National Park Service air quality sites. We will develop a detailed written protocol for operator use. The operators for the MDN and at least the one NPS site in Nevada will use the operating instructions and participate in a 2-month program of deployment, collection and shipping of samples to Frontier Geosciences for analyses.

In addition, through cooperation with NDEP developed sorbents will be deployed for short term field testing in transects downwind (~10, 50, 100, 200 km) of two known anthropogenic sources of Hg and one area of significant natural Hg enrichment. Site selection for assessment of impact of anthropogenic sources will have to be with out interferences from local geologic sources and will have to be carefully chosen with respect to air mass transport. We will use available trajectory information for the state to develop deployment scenarios. Simultaneous deployment of SOx passive samples may also help with source assessment. These activities will provide a test for the for use of the passive sampling system for identifying if there are hot spots developed in association with anthropogenic sources of Hg. For this component of the project NDEP will help locate sampling sites and also with deployment and collection of the samplers. This will allow us to predict whether the developed system may be applied cheaply and allow for air concentrations to be measured at multiple sites simultaneously. Use of NDEP personnel and MDN operators will allow us to assess the ease of deployment, how user friendly the methods are and the clarity of the written protocols. Built into the deployment scheme will be a variety of Quality Assurance Quality Control checks to assess for potential sources of contamination (i.e. field blanks, samplers that are removed and placed into sample vials without being deployed in the field, etc.).

2). **<u>Associated work products to be developed</u>**

I. It is the goal of this project to develop a relatively low cost easily deployable means of assessing air Hg concentration and speciation. This will include a detailed written protocol for sampler deployment, collection and transportation to laboratory for analyses, as well as analytical procedures and quality control procedures for analyses. This protocol will also describe the limitations of data collected and how it will be used for ambient monitoring and source apportionment.

II. Peer reviewed papers describing:
1) Air Hg speciation at urban and rural sites in Nevada
2) Potential for dry versus wet deposition at MDN sites and significance of these processes in western systems
3) Development of methods for static measurement of elemental reactive and particulate Hg.

III. Quarterly reporting to NDEP.

3). **Benefits to the public**

This project will develop methods that may be used to assist state and local agencies in characterizing the Hg speciation and concentration and potential impacts associated with anthropogenic and natural sources at the local to regional scale. This has significant benefit to the public for currently the only means of measuring atmospheric Hg are expensive and may only be deployed by trained personnel. This means that there is little information on the potential for Hg dispersal downwind of anthropogenic sources. Because of this there is much speculation and concern regarding on the impact of anthropogenic sources of Hg with little data to support or refute concerns. For example, Utah and Idaho have suggested that Hg originating in Nevada is contaminating watersheds in their states. We will test to see if the passive system used simultaneously with passive SOx samplers can be used to identify anthropogenic inputs. Development of ambient monitoring capabilities that will allow us to determine the potential for elevated Hg concentrations or deposition that may be applied by others would be of significant benefit for similar concerns are present across the Nation. Some work will be done as part of this project on the ability of these samplers to allow us to determine dry deposition. Based on the data collected at the Reno-DRI site the potential use of the passive samplers for assessing dry deposition will begin to be investigated. Since Hg is a high priority hazardous pollutant with high public visibility, due especially to its impact on fisheries, this project will fill a significant data gap that is important for public understanding.

4). **How project outcomes will be transferable/applicable to other like scenarios in other sectors**

Mercury is an issue across the country. Laboratory tests and field development of an easily deployable ambient sampling system would provide a product that would be transferable to areas across the United States. Deployment in Reno and Seattle will allow us to assess their performance in different climatic regimes. Controlled laboratory studies will also allow us to investigate sampling system use under a variety of environmental conditions.

Carefully constructed written protocols for system use, which will be checked for clarity in the second year by application and a variety of personnel would ensure transferability to those operating ambient air monitoring systems. Ideally we would like to develop a passive sampling system that would provide air Hg concentrations and speciation within the framework of the MDN sites and may become an integral component of these sites.

5). **Plan for tracking and measuring progress toward achieving expected environmental outputs/outcomes identified**

Laboratory tests of materials will be done simultaneous with field testing at both Frontier and UNR allowing us to simultaneously develop a passive sampling system that will work within ambient environmental conditions. During the last ½ year of the project deployment down wind of two major anthropogenic point sources as well as a natural source of Hg in Nevada will allow us to assess if this project will provide information on local and regional Hg deposition downwind of point sources. Deployment and use of the samplers at the MDN and a NPS air quality site in the second year, will allow us to assess operator ease of use.

The timeline described above will be carefully followed with NDEP oversight. NDEP will require and critique quarterly reviews of the project.

6). **Explanation of how project success will be evaluated**

Project success will be evaluated during the first year based on the performance of the passive samplers in the laboratory versus the field and how the data compares with Hg speciation and dry deposition being measured by other methods. This will allow us to do a method assessment using methods demonstrated to measure Hg speciation. Use of the controlled laboratory studies where exposures can be well quantified will allow us to assess sampler performance and develop statistical relationships between passive sampler uptake and exposures. Algorithms will be developed based on laboratory data that will allow us to predict relationships between exposures and amount absorbed that may be tested in the field. Because we will deploy the samplers in the field with systems that measure the concentration and speciation of Hg (also be applied to check data in the laboratory) we will be able to compare lab and field performance with other methods. This will allow for a quantitative method assessment.

Successful deployment of the samplers by field personnel at the MDN, NPS and downwind of sources with Quality Assurance/Quality Control checks in place that show that they have been utilized successfully without contamination will also be used to evaluate success. This latter component that includes state personnel deployment of filters will allow us to assess how practical the method development is for use by others.

7). **Description of the roles of applicants and partners**

This project consists of a partnership between the Nevada Division of Environmental Protection, University of Nevada and Frontier Geosciences. Dr. Colleen Cripps, Deputy Administrator, and Michael Elges, Chief of the Bureau of Air Pollution Control. The NDEP will have general oversight of the project, provide input as to how well data collected is addressing state issues, and provide equipment and technical support. Technical support will include field personnel who will follow the protocols developed by UNR and Frontier Geosciences for field deployment during year 2. This will allow for assessment of the ability of state agencies to understand and utilize the methods developed, and comment and critique on the protocols. Quarterly reports required by this agency will keep the research program on track. Their partnership with UNR will assure that a practical research product is developed. In addition, NDEP will assist through loan of sampling equipment used for ambient air quality monitoring such as NOx, SOx and Ozone analyzers.

University of Nevada will be responsible for most of the laboratory and field work with oversight and overall management of the project by Mae Gustin. Two graduate students, as well as a part-time technician and an undergraduate will work on lab and field studies. Frontier Geosciences will do initial studies on sorbent materials. In addition they have national oversight of data analyses for the MDN sites. Through this project the Reno MDN site will be established and data from all three Nevada sites will be processed through the MDN sites. Eric Prestbo with Frontier is part of the ongoing College of Agriculture HATCH project, so he is a participant in ongoing work. He will continue to work on the development of the surrogate static sampling surfaces and/or sorbents and collaborate with students and Mae Gustin at UNR. Eric will work on sorbent development and testing at Frontier and help design laboratory studies to be completed at UNR and participate in data assessment and interpretation. Periodically sample splits will be analyzed at both laboratories for Quality Control checks.

Partnerships with DRI, Lesperance and Gibbs Ranch and EPA Region 9, which are already in place, will be continued. A partnership with at least one NPS ambient air quality site manager will also occur. This collaboration with those collecting the data at current ambient monitoring sites will allow us to demonstrate and integrate our methods into a current monitoring system.

8). **Biographical information of key personnel**

Because it would consume significant space to include complete resumes a brief summary of expertise of each person that will contribute to the project is given and if appropriate a web page link where there is more information.

Dr. Mae Gustin is an Associate Professor in the Department of Natural Resources and Environmental Sciences at the University of Nevada. She has been doing Hg research since 1994. Funded projects and a complete list of publications (> 40 mercury related) can be found at www.cabnr.unr.edu/gustin. Mercury research is her primary focus with the EPA STAR program, NSF, USDA, EPRI and other agencies supporting her research programs.

Dr. Eric Prestbo is a Senior Research Scientist with Frontier Geosciences, Inc working within the Research & Consulting Group. Eric Prestbo earned his Ph.D. in Atmospheric Analytical Chemistry from the University of Washington in 1992. Dr. Prestbo has 20 years experience in atmospheric research studies. For the past 11 years Dr. Prestbo has focused on atmospheric mercury and trace metal research including reaction rate measurements, speciation method development for ambient air and flue gas, fate and effects in combustion plumes and wet/dry deposition measurements. Dr. Prestbo has achieved recognition among his peers as a leader in the field of atmospheric trace metal speciation research and method development. He continues to be engaged in the US Department of Energy (DOE), Electric Power Research Institute (EPRI), and Energy and Environment Research Center (EERC) programs to develop an accurate and reliable Hg speciation method for coal flue gas. Working with collaborating scientists on US DOE and EPRI programs designed to evaluate new control technologies, Dr. Prestbo has been instrumental in the application of a very simple, inexpensive and fast turnaround technique for total and speciated Hg in flue gas.

Dr. Colleen Cripps is the Deputy Administrator for the Nevada Division of Environmental Protection. Colleen Cripps has a Ph.D in Biochemistry and a Masters Degrees in Public Administration and in Ecology. She has been with the Division for over 16 years first in the Waste Management Programs, then in Air Quality.

Michael Elges is the Chief of the Nevada Division of Environmental Protection's Bureau of Air Pollution Control. Michael has been with the Air Quality program for over 15 years.

Seth Lyman is the graduate student who is working on the College of Agriculture HATCH project. He graduated from the University of Utah with a BS in Environmental Science and a 3.95 GPA. He is just finishing his first year of graduate school in the Environmental Sciences and Health Program.

9). **<u>Other information</u>**

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3. <u>Detailed itemized budget-specify unit costs</u>

The detailed budget is attached with explanation of categories below

a. ***Personnel***

One month of Mae Gustin-project principle investigator salary will be cost shared each year.

Eric Prestbo-three weeks of salary is included.

Two graduate students will work on the project as well as a half time technician.
One of the graduate students salary is paid by an ongoing grant.

b. ***Fringe***
At UNR the fringe rate for Gustin (27%) and one graduate student (10%) is cost shared Fringe is included for the additional graduate student, the technician (27%) and undergraduate (2%) are included in the contract.

d. ***Travel***
Travel is included for trips to field sites and between Frontier and UNR.

e. ***Equipment***
A Tekran 1130/1135 unit is included. These two components of the system are not available for measuring air speciation. UNR has the Tekran 2537A to measure total Hg collected by these system components but needs these to adequately be able to carry out this project. The equipment from EPA region 9 will continue to be available for deployment to the MDN sites periodically throughout the year as they are now.

f. ***Supplies***
Supplies for laboratory studies, field studies and equipment maintenance are expensive. As are equipment replacement part, carrier gases and reagents. In testing of sorbent materials use of materials and costs are high. We have budgeted $20,000 each year to cover operating costs.

g. ***Other***

h. ***Direct costs-see spreadsheet***

i. ***Indirect costs***
Indirect costs at UNR applied will be 26% this is less than the typical 45% .

j. ***Total cost -see spreadsheet***

4. Quality assurance narrative <u>To what extent does the applicant describe their intent and plan to implement a Quality system 8 points</u>
Mercury is ubiquitous in the environment. Because of this clean handling protocols are necessary for all sample collection and data analyses procedures.
Because this project involves data collection using new methods Standard Operating Procedures (S.O.P.s) for clean handling and sampling protocols, as well as sample storage and transport, and laboratory analyses protocols will need to be developed, tested, and revised. Detailed S.O.P.s will be written and modified as from the onset of this project.

The biogeochemistry laboratory at UNR has been using clean handling protocols for mercury over the past 10 years and we have established our ability to measure mercury and methyl mercury in a wide range of environmental materials. This is proven by our success with peer reviewed journal articles on the data collected and success with funded projects (www.unr.cabnr.edu/gustin) Frontier geosciences has established themselves as the premier Hg analytical laboratory for Hg in the Unites States and in possibly the world. Both laboratories follow standard EPA method protocols and have developed S.O.P.s specifically for trace Hg cleaning and analytical methods for their laboratory. S.O.P.s for this project will be agreed upon by UNR, Frontier Geosciences, and the State of Nevada. The latter will comment on the likelihood of state agencies being able to carry out such procedures.

UNR has already gone to significant effort to develop Quality Assurance Quality Control procedures for the polysulfone ion exchange membranes currently being tested.

Local-Scale Air Toxics Ambient Monitoring
66-034
Budget Summary

		Federal Funds			Cost Share		
Salary		Year 1	Year 2	Total	Year 1	Year 2	Total
	Gustin				7,159	7,159	14,318
	Prestbo	18,000	18,000				
	Technician	42,500	42,500	85,000			
	Graduate	16,800	16,800	33,600	16,800	7,000	23,800
	Casual Labor			0	1,800		1,800
	Undergraduate	1,800	1,800	3,600			
Total Salary		79,100	79,100	158,200	25,759	14,159	39,918
Fringe							
	Professional (27%)				1,933	1,933	3,866
	Technician (27%)	6,075	6,075	12,150			
	Graduate (10%)	1,680	1,680	3,360	1,680	700	2,380
	Undergraduate (2%	36	36	72			
Total Fringe		7,791	7,791	15,582	3,613	2,633	6,246
Total Salary & Fringe		86,891	86,891	173,782	29,372	16,792	46,164
Travel		3,000	3,000	6,000			
Total Operating		35,900	35,900	71,800	55,000	55,000	110,000
Equipment		71,725		71,725	10,000	10,000	20,000
Tuition		1,600	1,600	3,200	1,600	1,600	3,200
Total Direct Cost		199,116	127,391	326,507	95,972	83,392	179,364
Modified Total Direct Cost		71,891	71,891	143,782	29,372	16,792	46,164
Indirect Cost (26%)		18,692	18,691	37,383	7,637	4,367	12,004
Waived Indirect Cost					13,659	13,659	27,318
Total Cost		217,808	146,082	363,890	117,268	101,418	218,686

Unversity of Nevada Reno Budget

		Federal Funds			Cost Share		
Salary		Year 1	Year 2	Total	Year 1	Year 2	Total
	Gustin				7,159	7,159	14,318
	Prestbo						
	Technician	22,500	22,500	45,000			
	Graduate	16,800	16,800	33,600	16,800	7,000	23,800
	Casual Labor			0	1,800		1,800
	Undergraduate	1,800	1,800	3,600			
Total Salary		41,100	41,100	82,200	25,759	14,159	39,918
Fringe							
	Professional (27%)				1,933	1,933	3,866
	Technician (27%)	6,075	6,075	12,150			
	Graduate (10%)	1,680	1,680	3,360	1,680	700	2,380
	Undergraduate (2%	36	36	72			
Total Fringe		7,791	7,791	15,582	3,613	2,633	6,246
Total Salary & Fringe		48,891	48,891	97,782	29,372	16,792	46,164
Travel		3,000	3,000	6,000			
Total Operating		20,000	20,000	40,000			
Equipment		62,615		62,615			
Tuition		1,600	1,600	3,200	1,600	1,600	3,200
Total Direct Cost		136,106	73,491	209,597	30,972	18,392	49,364
Modified Total Direct Cost		71,891	71,891	143,782	29,372	16,792	46,164
Indirect Cost (26%)		18,692	18,691	37,383	7,637	4,367	12,004
Waived Indirect Cost					13,659	13,659	27,318
Total Cost		154,798	92,182	246,980	44,631	32,051	88,686

National Atmospheric Deposition Network - MDN Budget

	Federal Funds			Cost Share		
Salary	Year 1	Year 2	Total	Year 1	Year 2	Total
Gustin						
Prestbo						
Technician						
Graduate						
Casual Labor						
Undergraduate						
Total Salary						
Fringe						
Professional (27%)						
Technician (27%)						
Graduate (10%)						
Undergraduate (2%						
Total Fringe						
Total Salary & Fringe						
Travel						
Total Operating	10,900	10,900	21,800	20,000	20,000	40,000
Equipment	9,110		9,110			
Tuition						
Total Direct Cost	20,010	10,900	30,910	20,000	20,000	40,000
Modified Total Direct Cost						
Indirect Cost (26%)						
Total Cost	20,010	10,900	30,910	20,000	20,000	40,000

Frontier Geosciences Budget

		Federal Funds			Cost Share		
Salary		Year 1	Year 2	Total	Year 1	Year 2	Total
	Gustin						
	Prestbo	18,000	18,000	36,000			
	Technician	20,000	20,000	40,000			
	Graduate						
	Casual Labor						
	Undergraduate						
Total Salary		38,000	38,000	76,000			
Fringe							
	Professional (27%)						
	Technician (27%)						
	Graduate (10%)						
	Undergraduate (2%						
Total Fringe							
Total Salary & Fringe		38,000	38,000	76,000			
Travel							
Total Operating		5,000	5,000	10,000	10,000	10,000	20,000
Equipment							
Tuition							
Total Direct Cost		43,000	43,000	86,000	10,000	10,000	20,000
Modified Total Direct Cost							
Indirect Cost (26%)							
Total Cost		43,000	43,000	86,000	10,000	10,000	20,000

NDEP - EPA Region 9 Budget

	NDEP Cost Share			EPA Region 9 Cost Share-Loan of Equipment		
Salary	Year 1	Year 2	Total	Year 1	Year 2	Total
Gustin						
Prestbo						
Technician						
Graduate						
Casual Labor						
Undergraduate						
Total Salary						
Fringe						
Professional (27%)						
Technician (27%)						
Graduate (10%)						
Undergraduate (2%						
Total Fringe						
Total Salary & Fringe						
Travel						
Total Operating	25,000	25,000	50,000			
Equipment				10,000	10,000	20,000
Tuition						
Total Direct Cost	25,000	25,000	50,000	10,000	10,000	20,000
Modified Total Direct Cost						
Indirect Cost (26%)						
Total Cost	25,000	25,000	50,000	10,000	10,000	20,000