

DRAFT – The Mercury Trends Network (MTN): A New Initiative for the National Atmospheric Deposition Program

13 July 2006

This draft proposal was written for the Special NADP Meeting on the Mercury Trends Network (MTN) Initiative, to be held May 1, 2006 in Riverside, CA. The purpose of this meeting was to receive input from potential stakeholders in a new network to compute mercury total deposition, the MTN. The format of this proposal follows the “Proposal for New NADP Initiatives” specified in the National Atmospheric Deposition Program’s Quality Management Plan. This revised version includes changes determined from discussions at the May 1, 2006 NADP meeting and a NADP-sponsored meeting of mercury scientists involved with research to measure and model atmospheric mercury, June 27, 2006.

The contents of this proposal should not be taken as the final description of the measurement methods and data analysis procedures of the MTN. This proposal will be revised based on input received from stakeholders and the scientific community. Comments are welcome – Please contact the initiative advocates listed below.

1. Initiative Description

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1.2 Objectives

This initiative establishes a Mercury Trends Network (MTN) to serve scientists, modelers, policy makers, federal, state, and tribal government agencies, and the public. The MTN will be the part of the National Atmospheric Deposition Program-Mercury Deposition Network (NADP-MDN) and is intended to provide a more complete understanding of the fate of mercury emissions with respect to total (i.e., wet and dry) deposition. The MTN will measure atmospheric mercury species via automated (3-hour interval) and manual (6-day interval) gas and particulate measuring systems and event-based mercury wet deposition. Meteorological variables for computing mercury wet deposition and estimating mercury dry deposition will be measured or obtained from collocated programs. Data will be collected with standardized methods developed through U. S. Environmental Protection Agency (USEPA) research, quality-assured, and archived in an on-line database.

Specific objectives to be achieved with the MTN are to:

- Determine the status and trends in the
 - Concentrations of ambient air mercury species including
 - Reactive gaseous mercury (RGM)
 - Particulate bound mercury (PHg)
 - Elemental mercury (Hg^0)
 - Wet, dry and total atmospheric deposition of mercury
- Operate MTN stations to monitor the status and trends in mercury deposition for ecosystems that are influenced by local, regional, continental and global scale mercury sources. The priority will be to establish MTN stations to evaluate the efficacy of forthcoming mercury emission changes from implementation of state and federal regulations
- Evaluate the status and trends in total deposition of atmospheric mercury to ecosystems with a high potential for mercury methylation and mercury bioaccumulation in fish and wildlife.

- Provide the capability to link changes in mercury emissions to changes in atmospheric mercury concentrations and total deposition of atmospheric mercury
- Improve the information base for models of atmospheric mercury chemistry, transport, and deposition

1.3 Duration

The MTN will begin operation as a transition network in fiscal year 2007 (FY2007, October 1, 2006 through September 30, 2007) and operate indefinitely.

1.4 Background

In 2005, the USEPA promulgated the Clean Air Interstate Rule (CAIR, 40 CFR 52, 72, 96) and the Clean Air Mercury Rule (CAMR, 40 CFR 60, 72, 75) to control emissions of mercury and other pollutants from the power generating sector (Code of Federal Regulations, 2005a and 2005b). A national long-term monitoring network in the United States will help better assess the impact that utilities have on mercury deposition and the resulting impacts on fish and wildlife. The changes in mercury emissions projected from the rules necessitate a national network that can track geographic patterns and temporal trends in mercury atmospheric concentrations and atmospheric deposition. Predictive models for the total deposition of atmospheric mercury will help forecast the time frame of progress in mercury control. Measurements of atmospheric mercury species concentrations, coupled with event-based sampling of mercury wet deposition, would provide the data for validation and calibration of models for dry, wet, and total deposition of atmospheric mercury (Bullock and Brehme, 2002; Cohen and others, 2004; Miller and others, 2005; Seigneur and others, 2004). Accessible, standardized national data from this kind of monitoring are currently unavailable, but were recommended by a team of mercury scientists, sponsored by the Society of Environmental Toxicology and Chemistry, as critical for improving the understanding of the fate of atmospheric mercury (Mason and others, 2005).

Three atmospheric mercury species are of interest because they can contribute to dry deposition (Bullock and Brehme, 2002; Cohen and others, 2004; Miller and others, 2005; Seigneur and others, 2004): RGM, PHg, and Hg⁰. Based on models, the dry deposition of

mercury can be from 0.25 to 3 times the rate of wet deposition depending on location. Close to sources that emit RGM and PHg, the impact of mercury dry deposition may be substantial. Even though the estimated Hg⁰ deposition velocity is small, it normally comprises more than 98% of the total mercury in air at ground level, so can be a significant route for dry deposition, especially in forested ecosystems.

The NADP is well-suited for collection and dissemination of data on atmospheric mercury speciation/dry deposition and mercury wet deposition in a timely and organized fashion to a national audience. The NADP operates the MDN to quantify mercury concentrations and wet deposition from weekly samples at 92 stations in North America (National Atmospheric Deposition Program, 2005). In development of a national monitoring strategy for mercury, personnel from the USEPA and state agencies including Wisconsin, Minnesota, Indiana, Pennsylvania, Louisiana, and Florida recommended that the NADP-MDN be expanded to include dry deposition monitoring to complement MDN wet deposition measurements (U.S. Environmental Protection Agency, 2005). This proposal for a MTN, to be implemented through the NADP, is to immediately establish a national network of monitoring stations in the United States, with the potential for long-term expansion throughout North America.

2. How will the new initiative meet the Mission, Objective, and Philosophy of the NADP?

2.1 The NADP Mission and Philosophy

The NADP provides quality-assured data and information in support of research on the exposure of managed and natural ecosystems and cultural resources to acidic compounds, nutrients, mercury, and base cations in precipitation (NADP Quality Management Plan, 2003). The MTN will complement the existing NADP-MDN program by addressing the importance of total mercury deposition, not just wet deposition. Thus, the MTN will expand the relevance of the NADP in its mission to assess the exposure of natural ecosystems and the resulting impacts on wildlife and human health to atmospheric deposition.

2.2 The Link with the U.S. Department of Agriculture

The U.S. Department of Agriculture (USDA) is concerned with impacts on environmental quality in the nation's forests, and on the quality of food produced for U.S. consumption and export. The known bioaccumulation of mercury in aquatic ecosystems and its impact on fishery produce and recreational consumption is a direct concern of the USDA and other federal agencies such as the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), the Fish & Wildlife Service (F&WS), the National Park Service (NPS), the Tennessee Valley Authority (TVA), and the Food and Drug Administration (FDA). Information on source-receptor relationships is necessary for all federal agencies with supervisory authority for Class I Wilderness Areas, including the BLM, F&WS, NPS and the USDA-Forest Service.

Other cooperating agencies in the NADP have specific needs to assess mercury in the environment. Mercury is specifically targeted as an air toxic for research, monitoring, and emissions control in the 1990 Clean Air Act and Clean Water Act, and is part of programs such as state mercury Total Maximum Daily Load (TMDL) efforts, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA-NMFS), and USGS's National Water Quality Assessment (NAWQA). The NADP has historically and successfully anticipated the monitoring requirements of its cooperating agencies, and seeks to do so again with the MTN.

3. Information Added to the NADP

3.1 RGM, PHg and Hg⁰ Concentration

Above ground level (for example, 2 to 5 meters^a) concentrations of RGM, PHg and Hg⁰ will be measured at two frequencies, depending on what measurement protocol each station chooses to use:

- **Manual Systems.** Two consecutive 12-hour samples will be collected on a 6-day schedule resulting in measurements on a different day each week.

^aThe standard height of the sample inlet has not been determined, but heights from 2 to 5 meters have been considered.

- **Automated Systems.** Hg^0 is measured continuously at 5-minute integrated intervals. PHg and RGM are measured continuously at 3-hour intervals.

3.2 Concentrations of Mercury in Precipitation

The MTN will measure concentrations of total mercury in weekly wet deposition samples in a manner analogous to the NADP-MDN. If an MTN site sponsor desires, concentrations of total mercury may be measured on an event basis (within 24 hours from the end of the precipitation event) in a manner analogous to the NADP-MDN.

3.3 Meteorological Data

Each monitoring station will have an NADP-approved recording rain gauge and weather station equipped with a data logger.^b The weather station will measure at least six meteorological parameters, including wind speed, wind direction, air temperature, relative humidity, solar radiation, and leaf wetness. The data logger will archive the 15-minute averages of the meteorological parameters.

3.4 Mercury Deposition

3.4.1 Mercury Dry Deposition Fluxes

Mercury dry deposition fluxes will be estimated based on the concentration of atmospheric mercury species and the modeled vertical deposition velocity. The vertical deposition velocity for each species will be computed with an inferential model using the on-station meteorological data. Dry deposition values will be computed on a 12-hour basis for both systems.

3.4.2 Mercury Wet Deposition Fluxes

Total mercury wet deposition will be calculated from precipitation concentrations following the standard procedures of the NADP-MDN and reported on a weekly or an event basis.

^b MTN sites may also access hourly meteorological data through approved collocated monitoring programs such as the Clean Air Status and Trends Network (CASTNET) and the National Weather Service (NWS).

3.4.3 Total Mercury Deposition

Total mercury deposition will be calculated from dry deposition and event-based wet deposition data, and reported on a seasonal and annual basis at each monitoring station. The estimates will be constrained with accompanying limits of uncertainty.

4. Data Products

4.1 MTN Database and Summary Reports

4.1.1 Online Database

The MTN database will be available free to the scientific community via the Internet. Online data products will include concentrations of atmospheric mercury species and concentrations of mercury in precipitation. All data will have explanatory notes, including QC flags and sample information. In a separate part of the database, dry deposition flux estimates, wet deposition fluxes, and estimates of mercury total deposition fluxes will be stored with supplementary explanations.

An ancillary data archive will be available on the Internet, including meteorological data and vertical deposition velocity computations. This will allow data users to run their own models to estimate dry deposition.

4.1.2 Summary Reports

Annual MTN summary reports will include statistical summaries and plots of annual atmospheric mercury species concentrations, precipitation mercury concentrations, and deposition values.

4.2 Standard Operating Procedures (SOPs)

4.2.1 Manual Systems

- SOPs for RGM, PHg and Hg⁰ concentration measurements
- Electronic field observer form and sample analysis request
- Equipment setup and training manual

4.2.2 Automated Systems

- SOPs for RGM, PHg and Hg⁰ concentration measurements
- Electronic field observer form and sample analysis request
- Equipment setup and training manual

4.2.3 Precipitation Measurements

- NADP-MDN SOP for precipitation samples
- MDN Electronic field observer form and sample analysis request

4.2.4 Meteorological Measurements

- SOPs for meteorological data retrieval, processing, and submission

4.3 Quality Assurance

- MTN Quality Assurance Plan (as an appendix to the NADP Network QA Plan)
- MTN performance audit and survey procedures
- Annual QA/QC report for laboratory and field samples
- Data management SOPs

5. Protocols

5.1 Atmospheric Mercury Species

Concentrations of RGM, PHg, and Hg⁰ will be measured at monitoring stations instrumented with either a manual or automated system that has a sample inlet at a standard distance above ground level.

5.1.1 Manual Systems

A monitoring station with a manual system will collect two consecutive 12-hour air samples collected on a 6-day schedule. Methods are from Landis and others (2002) and from the U.S. Environmental Protection Agency (1999). Figure 1 presents the components of the manual system. Each monitoring station will have two timer-controlled sampling systems. The sampling train will consist of a quartz annular denuder (for RGM), a quartz particulate-filter holder (for PHg), and dual traps of gold-coated quartz (for Hg⁰). Sampling trains will be exchanged using standard procedures and ultra-

clean protocols and shipped to the NADP Hg Analytical Laboratory (HAL) for analysis. Method development studies by the U.S. Environmental Protection Agency (Landis and others, 2002) established that measurements of mercury species concentrations collected with the manual system were equivalent to those collected with an automated system.

5.1.2 Automated Systems

A monitoring station with an automated system will have a Tekran model 2537A analyzer with model 1130 and 1135 speciation units (Landis and others, 2002). Figure 2 presents the components of the automated system. The mercury detector consists of a Cold Vapor Atomic Fluorescence Spectrometer (CVAFS). Similar to the manual system, the system includes a quartz annular denuder, quartz particulate-filter, and gold traps. This system runs automatically and produces 5-minute integrated Hg^0 values while collecting RGM and PHg over a 3-hour integration period. RGM and PHg values are generated every 4 hours (i.e., 6 values per day). The system is designed to be coupled to a computer and data logger for data archive, telemetry and remote checking of instrument status.

5.2 Mercury in Precipitation

Concentrations of total mercury will be determined in precipitation samples collected on a weekly schedule. Each monitoring station will have an automated collector and sampling train like those currently used in the NADP-MDN. The sampling train will be exchanged weekly, based on a standard procedure and clean-sampling protocols. Samples will be analyzed by the HAL.

5.3 Meteorological Data

Each monitoring station will have a rain gage and weather station with data logger. A recording rain gage accepted by the NADP will be used to measure precipitation amount and to record the function of the automated wet deposition collector. These precipitation data will be used to compute total mercury wet deposition following standard procedures of the NADP-MDN. A weather station with data logger will be used to collect and archive values for at least six meteorological parameters (wind speed, wind direction, air temperature, relative humidity, solar radiation, and leaf wetness/dew.) The weather

station data will be used in an inferential model for computing vertical deposition velocities.

5.4 Estimated Mercury Dry Deposition

A daily estimate of mercury dry deposition will be computed with the concentrations of atmospheric mercury species and the modeled vertical deposition velocities for those species. One inferential model that has been considered was developed by NOAA (Hicks and others, 1985), commonly called the “Big Leaf Model.” Some assumptions can be made to apply this model to atmospheric mercury species. Other inferential models will be considered based on input received from the scientific community.

For concentrations measured with the manual system, the modeled vertical deposition velocities will be computed and dry deposition will be estimated for each 12-hour sample. For concentrations from the automated system, 12-hour average concentrations will be computed for 1-hour time period Hg^0 data and 3-hour time period RGM and PHg data. Vertical deposition velocities will be computed on a 12-hour basis, and estimated dry deposition will be reported on a 24-hour basis.

5.5 Total Deposition of Atmospheric Mercury

Daily wet deposition data and daily dry deposition data will be combined to estimate quarterly and annual total deposition of atmospheric mercury at each monitoring station. The estimates will be constrained with accompanying limits of uncertainty.

5.6 Data Management

Each MTN station with an automated system will be connected to the Internet for timely data download to be used for internal MTN diagnostic purposes and public outreach through simple web-based graphical data plots. (The graphical plot data available to the public will be provisional and limited. Data for diagnostic purposes will be accessible to just the station operator, sponsor and MTN staff.) The NADP on-line archive will be the repository for daily values of atmospheric mercury species concentrations, mercury wet deposition, and calculated mercury dry deposition. Quarterly data sets will be posted within 6 months of the end the quarter. Ancillary data from the monitoring stations,

including meteorological data, will be maintained in a digital archive available through the NADP. Maps and charts will be posted by NADP showing the estimated quarterly and annual total deposition of atmospheric mercury. Standard procedures for network operation, quality assurance, and data management will be documented and managed by an NADP steering committee.

6. Quality Assurance and Quality Control

A quality-assurance plan for the MTN will be developed for the measurement of atmospheric manual and automated mercury speciation monitoring, including field and laboratory components. Several draft-level quality assurance documents are already in existence for the automated mercury speciation instrumentation that can be drawn from to produce a NADP-MTN specific quality assurance plan. The quality assurance plan for the NADP-MDN will be followed for collection and analysis of precipitation samples for mercury. As needed, this plan will be adapted for the event-based sampling schedule.

6.1 Field Quality Assurance

6.1.1 Station Audits and Performance Surveys

Each MTN station will have an initial visit during startup to verify that the measurements systems and data logging is functional and the operator is sufficiently trained to maintain the station at the level required by the program. After startup, each MTN station will be visited by a technician annually to verify the operation of equipment, evaluate operator performance, and to perform maintenance.

6.1.2 RGM, PHg and Hg⁰ Concentrations

Field sampling quality assurance protocols have been developed for research programs. They will be consolidated and standardized for the MTN based on input from other scientists.

6.1.2.1 Manual Systems. For manual systems, a field observer form and checklist will be used to verify proper air flow and sampler temperature, and the lack of system leaks each time the sampling train is replaced. Field blanks, trip blanks, and collocated duplicate samples will be prepared on a specified schedule.

6.1.2.2 Automated Systems. The quality assurance procedures to establish for RGM, PHg and Hg⁰ concentration measurements in automated systems are detector calibration, contamination prevention, air flow calibration, leak checking, temperature control and ensuring the CVAFS detector is maintained and operates within acceptable limits. For example, the detector lamp needs to be checked and adjusted at least monthly and the system checked for leaks weekly whenever denuders and filters are replaced.

6.1.3 Concentrations of Mercury in Precipitation.

Field QA procedures for the monitoring of precipitation mercury concentrations will be analogous to those established in the NADP-MDN.

6.1.4 Meteorological Measurements

Weather station data will be verified per manufacturers' recommendations, including routine, independent calibration of the sensors. Sensor operation will be checked each time data are retrieved from the data logger.

6.2 Laboratory Quality Assurance

Laboratory quality assurance procedures will ensure that analytical measurements are not adversely influenced by measurement artifacts.

6.2.1 Manual Systems

For the manual method samples, quality assurance procedures will be analogous to those in place for the HAL, and will include

- Laboratory sample train blanks
- Preparation and trip blanks
- Calibration standard verification
- Calibration blanks

6.2.2 Automated Systems

Laboratory quality assurance for the automated system will center around preparation of the sample denuders and regenerable filters. Calibration standards are being developed for the automated system and may be provided by the laboratory for quality assurance.

7. Data Quality Criteria

Data quality acceptance criteria will be established, including individual sample quality rating codes and completeness criteria for inclusion of station data in summary maps and reports.

7.1.1 RGM, PHg and Hg⁰ Concentrations

7.1.1.1 Manual Systems. Individual 12-hour samples will be assigned a Quality Rating Code of A, B or C; criteria will be outlined in the data management SOP. A minimum of 75% data completeness will be required for monthly and seasonal averages. For annual summaries, a minimum of 50% data completeness will be required in each of the 4 seasons.

7.1.1.2 Automated Systems. 3-hour speciated concentrations will be assigned a Quality Rating Code of A, B or C; criteria will be outlined in the data management SOP. A minimum 75% data completeness will be required for daily, weekly, monthly, seasonal, and annual averages. For annual data summaries, a minimum of 50% data completeness will be required in each of the 4 seasons.

7.1.2 Concentrations of Mercury in Precipitation

The sample coding for precipitation mercury samples will be similar to those used for the NADP-MDN, and individual samples results will be assigned a Quality Rating Code of A, B or C. Completeness criteria for inclusion of station data in summary maps and reports will be identical to those for the NADP-MDN.

8. Demands on the NADP Program Office, the Mercury Analytical Laboratory, and Field Operators

8.1 NADP Program Office

The MTN will operate from the Program Office at the Illinois State Water Survey. The Program Office will:

- Coordinate and oversee the operation and quality assurance for the MTN.
- Communicate with member organizations that sponsor MTN monitoring stations.

- Maintain the on-line archive of monitoring data.
- Provide for review, upgrade, and expansion of the proposed monitoring network.

This effort is anticipated to require the support of 1.5 Full Time Equivalent (FTE) staff members during its first year of operation. As the MTN transition network expands, the Program Office will reallocate responsibilities of current staff, and anticipates the hiring of one additional staff member to support the MTN. This staff time will be funded through coordination costs paid by individual funding agencies to the Program Office. It is anticipated that the Program Office will coordinate the assembly of manual systems and support a parts depot. It is not anticipated that the Program Office will provide equipment support for automated systems. The MTN is not anticipated to impact operations at the NADP's Central Analytical Laboratory in any form.

8.2 The Mercury Analytical Laboratory

The NADP-HAL, currently Frontier Geosciences, will:

- Analyze the manual system sampling trains.
- Prepare replacement denuders and filters for manual and automated systems.
- Analyze precipitation samples.
- Provide calibration of automated systems.
- Provide technical support for operation and maintenance of systems.
- Implement laboratory quality assurance procedures.
- Coordinate with the USGS and the NADP Program Office for on-line distribution and archival of data.

The HAL anticipates the need to increase staffing as the MTN transition network expands, but this is dependent on the number of stations and how many stations employ manual versus automated systems. This staff time will be paid through sample analysis costs paid by individual funding agencies.

8.3 MTN Advocates

8.3.1 U.S. Geological Survey

Where needed and where cooperative funding arrangements are made, the USGS will:

- Assist with installation of new manual systems and related infrastructure.

- Assist with field quality assurance of manual systems.
- Compute and verify concentrations from manual systems.
- Assist with weather stations and compile and relay the mercury and weather data to the Program Office.
- Install, operate, and maintain the event-based MDN station.
- Assist with or conduct field trials of equipment or methods at MTN monitoring stations.

The USGS anticipates the required support of 1 FTE per multiple (3-4) manual systems in a state or region, depending on the level of involvement. The USGS will be represented on the MTN steering committee.

8.3.2 U.S. Environmental Protection Agency

The USEPA will provide policy, technical, and financial support to the Program Office and station sponsors. The USEPA will be represented on the MTN steering committee.

8.4 Station Sponsors and Operators

Station operators will be required to follow MTN SOPs for manual and automated system operation, quality assurance, and data submission to the NADP. Station sponsors will provide the support for station personnel.

9. Potential Funding Sources

It is anticipated that the MTN will attract a diversity of sponsors. Interested sponsors will include state agencies, tribal organizations, electric power industry partners, regional EPA offices, and the Canadian government. Long-term support is anticipated from the NADP's primary federal sponsors, which include the USEPA, the USGS, and the National Park Service. A minimum 5-year commitment will be requested from individual station sponsors.

10. Funds Transfers

All fund transfers for the MTN will be handled through the Program Office. State agencies will sign individual Memoranda of Agreements with the University of Illinois. Federal partners within the NADP Interagency Agreement will transfer funds to the

University of Illinois through that agreement. Sample analysis costs will be paid by the Illinois State Water Survey to the HAL.

11. How will the new initiative operate within the NADP committee structure?

Once established as a subnetwork of the NADP-MDN, it is suggested that a separate subcommittee (potentially a continuation of the MTN steering committee) be formally established by the NADP Technical Committee. This committee will interact with the NADP standing subcommittees through the Executive Committee.

12. Transitional needs

The MTN will begin operation as a transition network in FY2007 with sponsors and participants coordinated through the structure and organization of the NADP.

12.1 Planning Phase

The MTN will include national monitoring locations that are regionally representative; rural, urban, and suburban locations; areas with high levels of mercury emissions and mercury dry deposition; and sensitive ecosystems. A network design analysis has been performed as an example of how the planning phase will evaluate potential station locations, although local mercury emission sources were not specifically addressed in this preliminary analysis. Proposed locations are indicated in Figure 3 and Appendix A. The final network design analysis will incorporate modeling results and local and other mercury emissions sources, and consider potential impacts on sensitive ecosystems, watersheds and ecoregions.

The planning phase for the MTN will include these steps:

1. Funding and coordination of planning process
2. Network planning workshop for station sponsors and participants
3. Selection, evaluation, and approval of monitoring locations
4. Signing agreements with station sponsors for funding, equipment, services, and infrastructure
5. Negotiation with equipment manufacturers for specifications, costs, and delivery

6. Preparation of detailed project budget for equipment, laboratory services, infrastructure, field operations, data management, and network coordination

12.2 Startup Phase for Transition Network

The startup phase for the transition MTN will include these steps:

1. Funding and coordination for startup phase
2. Identification of equipment for continuous-automated and manually-operated systems
3. Identification of equipment for precipitation monitoring
4. Identification of weather station sensors, data loggers, and related infrastructure
5. Calibration and testing of equipment and infrastructure for automated systems
6. Calibration and testing of equipment for manual systems
7. Laboratory preparation of sampling supplies for sampling systems
8. Initiation and distribution of field operations procedures
9. Development and distribution of initial quality assurance procedures
10. Training of field personnel
11. Establishment and testing of data reporting system

12.3 Operation Phase for Transition Network

The operation phase for the transition MTN will include these steps:

1. Staged operation of precipitation monitoring, manual systems, automated systems, and meteorological monitoring at transition stations
2. Laboratory analysis of samples from precipitation samplers
3. Laboratory analysis of samples from manual systems
4. Evaluation and improvement of laboratory operations at full operation
5. Trouble shooting and maintenance of sampling systems
6. Estimates of daily dry deposition with air concentration and meteorological data
7. Estimates of daily wet deposition with precipitation concentrations and precipitation volume
8. Preparation and archival of daily concentration, wet deposition, and dry deposition values on a quarterly schedule
9. Digital storage of all monitoring data in a central database

12.4 Startup and Operation of MTN

The plan for startup and operation of the MTN will be based on the experience with sampling, analysis, quality-assurance, data reporting, and data management from the transition network.

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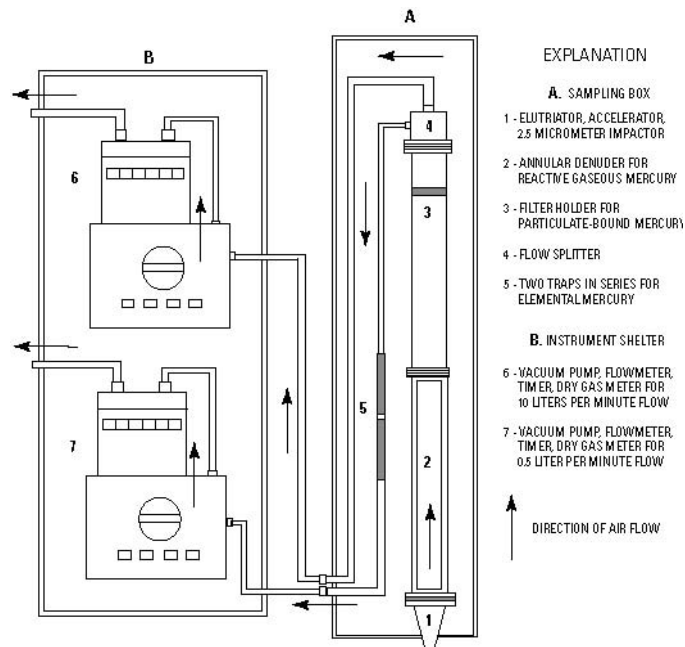


Figure 1. Components of manual sampling system for atmospheric mercury species.

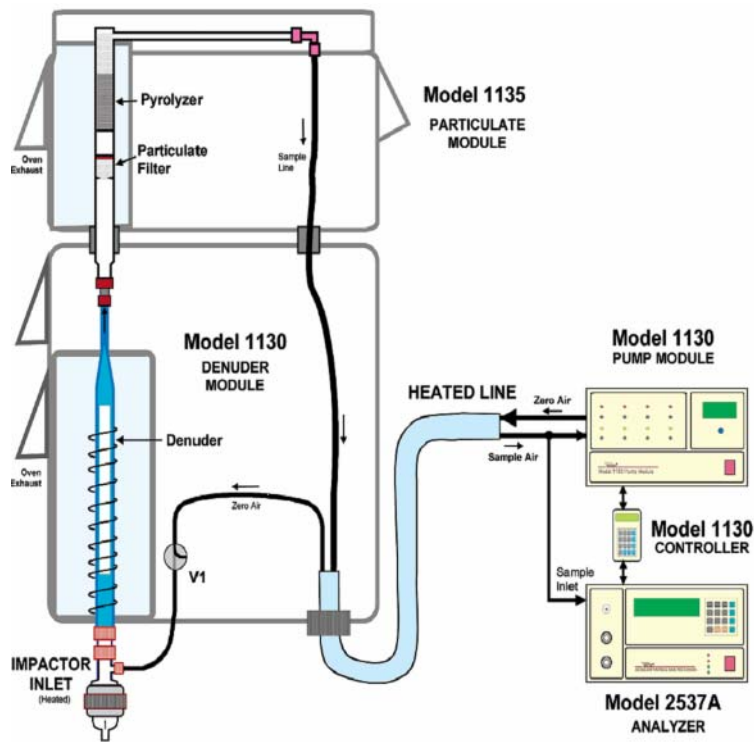


Figure 2. Components of automated sampling system for atmospheric mercury.

Appendix A – Initial Network Design Analysis for MTN Station Locations



Figure 3. Example locations for MTN stations based on preliminary network design analysis.

	Location	MDN*	CASTNET
1	Grand Canyon Natl. Park, Arizona		GRC474
2	Chiricahua Natl. Mon., Arizona		CHA467
3	Sequoia Natl Park, California	CA75	SEK402
4	Mesa Verde Natl. Park, Colorado	CO99	MEV405
5	Everglades Natl. Park, Florida	FL11	EVE419
6	Sumatra, Florida		SUM156
7	Bondville, Illinois	IL11	BVL130
8	Vincennes, Indiana		VIN140
9	Indiana Dunes Natl Lakeshore, Indiana	IN34	
10	Acadia Natl. Park, Maine	ME98	ACA416
11	Beltsville, Maryland		BEL116
12	Ann Arbor, Michigan		ANA115
13	Glacier Natl. Park, Montana	MT05	GLR468
14	Great Basin Natl. Park, Nevada		GRB411
16	Beaufort, North Carolina		BFT142
17	Oxford, Ohio		OXF122
18	Arendtsville, Pennsylvania	PA00	ARE128
19	Penn State, Pennsylvania		SCR180
20	Smoky Mts. National Park, Tennessee	TN11	GRS420
21	Walker Branch, Tennessee		ESP127
22	Shenandoah National Park, Virginia	VA28	SHN518
23	Underhill, Vermont	VT99	
24	Yellowstone National Park, Wyoming	WY08	YEL408
25	Longview, Texas	TX21	
26	Chase, Louisiana	LA10	
27	Coffeerville, Mississippi	MS30	
28	Erie, Pennsylvania	PA30	
29	Lake Geneva, Wisconsin	WI99	
30	Devils Lake, Wisconsin	WI31	

Table 1. Regionally representative locations for NADP Mercury Trends Network based on ecoregion, hydrologic unit, and existing atmospheric monitoring networks

	Location	Ecoregion	Hydrologic Unit	MDN*	CASTNET	NTN	AIRMoN
1	Grand Canyon Natl. Park, Arizona	Xeric West	Lower Colorado		GRC474	AZ03	
2	Chiricahua Natl. Mon., Arizona	Xeric West	Lower Colorado		CHA467	AZ98	
3	Sequoia Natl Park, California	Western Forested Mountains	California	CA75	SEK402	CA75	
4	Mesa Verde Natl. Park, Colorado	Xeric West	Upper Colorado	CO99	MEV405	CO99	
5	Everglades Natl. Park, Florida	Southern Florida Coastal Plain	South Atlantic-Gulf	FL11	EVE419	FL11	
6	Sumatra, Florida	Southern Coastal Plain	South Atlantic-Gulf		SUM156	FL23	
7	Bondville, Illinois	Corn Belt & Northern Great Plains	Upper Mississippi	IL11	BVL130	IL11	IL11
8	Vincennes, Indiana	Central & Eastern Forested Uplands	Ohio		VIN140	IN22	
9	Indiana Dunes Natl Lakeshore, Indiana	Glaciated Upper Midwest & Northeast	Great Lakes	IN34		IN34	
10	Acadia Natl. Park, Maine	Glaciated Upper Midwest & Northeast	New England	ME98	ACA416	ME98	
11	Beltsville, Maryland	Southeastern Temperate Forest, Plains, & Hills	Mid Atlantic		BEL116	MD03	
12	Ann Arbor, Michigan	Mostly Glaciated Dairy Region	Great Lakes		ANA115	MI52	
13	Glacier Natl. Park, Montana	Western Forested Mountains	Pacific Northwest	MT05	GLR468	MT05	
14	Great Basin Natl. Park, Nevada	Xeric West	Great Basin		GRB411	NV05	
15	Biscuit Brook, New York	Glaciated Upper Midwest & Northeast	Mid Atlantic	NY68	CAT175	NY68	
16	Beaufort, North Carolina	Eastern Coastal Plain	South Atlantic-Gulf		BFT142	NC06	
17	Oxford, Ohio	Corn Belt & Northern Great Plains	Ohio		OXF122	OH09	OH09
18	Arendtsville, Pennsylvania	Southeastern Temperate Forest, Plains, & Hills	South Atlantic-Gulf	PA00	ARE128	PA00	
19	Penn State, Pennsylvania	Central & Eastern Forested Uplands	Mid Atlantic		SCR180	PA15	PA15
20	Smoky Mts. National Park, Tennessee	Central & Eastern Forested Uplands	Tennessee	TN11	GRS420	TN11	
21	Walker Branch, Tennessee	Central & Eastern Forested Uplands	Tennessee		ESP127	TN00	TN00
22	Shenandoah National Park, Virginia	Central & Eastern Forested Uplands	South Atlantic-Gulf	VA28	SHN518	VA28	
23	Underhill, Vermont	Glaciated Upper Midwest & Northeast	Mid Atlantic	VT99			VT99
24	Yellowstone National Park, Wyoming	Western Forested Mountains	Missouri	WY08	YEL408	WY08	

*NOTE: New MDN stations will be established at locations selected for the network that do not already have MDN stations.

Table 2. Hydrologic units and ecoregions represented by potential locations for NADP Mercury Trends Network monitoring stations

	Hydrologic Unit	Potential location		Level II Ecoregion	Potential location
1	New England	x	1	Central Cultivated Great Plains	
2	Mid Atlantic	x	2	Central and Eastern Forested Uplands	x
3	South Atlantic-Gulf	x	3	Corn Belt and Northern Great Plains	x
4	Great Lakes	x	4	Eastern Coastal Plain	x
5	Ohio	x	5	Great Plains Grass and Shrublands	
6	Tennessee	x	6	Mostly Glaciated Dairy Region	x
7	Upper Mississippi	x	7	Glaciated Upper Midwest and Northwest	x
8	Lower Mississippi		8	Southeastern Temperate Forested Plains and Hills	x
9	Souris-Red-Rainy		9	Southern Coastal Plain	x
10	Missouri	x	10	Southern Florida Coastal Plain	x
11	Arkansas-White-Red		11	Texas-Louisiana Coastal and Mississippi Alluvial Plains	
12	Texas-Gulf		12	Western Forested Mountains	x
13	Rio Grande		13	Willamette and Central Valleys	
14	Upper Colorado	x	14	Xeric West	x
15	Lower Colorado	x			
16	Great Basin	x			
17	Pacific Northwest	x			
18	California	x			

Table 3. Rating of annual mercury emissions and annual mercury deposition for regionally-representative locations for NADP Mercury Trends Network monitoring stations, with additional locations based on annual mercury emissions and annual mercury deposition

	Location of regionally representative Mercury Trends Network monitoring station candidate	Level of annual mercury emissions ¹	Level of 2004 mercury wet deposition ²	Level of 2003 mercury wet deposition ²
1	Grand Canyon Natl. Park, Arizona	medium	no data	no data
2	Chiricahua Natl. Mon., Arizona	medium	no data	no data
3	Sequoia Natl Park, California	medium	no data	no data
4	Mesa Verde Natl. Park, Colorado	high	no data	no data
5	Everglades Natl. Park, Florida	no data	high	high
6	Sumatra, Florida	medium	high	high
7	Bondville, Illinois	high	medium	medium
8	Vincennes, Indiana	medium	medium	medium
9	Indiana Dunes Natl Lakeshore, Indiana	high	medium	medium
10	Acadia Natl. Park, Maine	no data	low	low
11	Beltsville, Maryland	medium	medium	medium
12	Ann Arbor, Michigan	medium	medium	medium
13	Glacier Natl. Park, Montana	no data	no data	no data
14	Great Basin Natl. Park, Nevada	medium	no data	no data
15	Biscuit Brook, New York	medium	medium	medium
16	Beaufort, North Carolina	medium	medium	medium
17	Oxford, Ohio	medium	high	medium
18	Arendtsville, Pennsylvania	medium	medium	medium
19	Penn State, Pennsylvania	high	medium	medium
20	Smoky Mts. National Park, Tennessee	medium	high	high
21	Walker Branch, Tennessee	medium	medium	medium
22	Shenandoah National Park, Virginia	medium	low	medium
23	Underhill, Vermont	medium	low	low
24	Yellowstone National Park, Wyoming	medium	no data	no data
25	Longview, Texas	high	medium	low
26	Chase, Louisiana	High	high	high
27	Coffeeville, Mississippi	High	high	high
28	Erie, Pennsylvania	high	medium	medium
29	Lake Geneva, Wisconsin	high	low	low
30	Devils Lake, Wisconsin	high	medium	medium

¹ Annual mercury emissions from coal-fired power plants in 1999 (U.S. Environmental Protection Agency, 2005), mapped as isopleth regions by U.S. Geological Survey (2005) were used to rate the mercury emissions where the proposed MTN monitoring station was located—low (less than 10 pounds per year), medium (10 to 100 pounds per year, high (greater than 100 pounds per year).

² Annual mercury wet deposition in 2004 and 2003, mapped as isopleth regions (National Atmospheric Deposition Program, 2005 and 2004) were used to rate the mercury deposition where the proposed MTN monitoring station was located—low (less than 10 micrograms per year); medium (10 to 14 micrograms per year); and high (more than 14 micrograms per year).