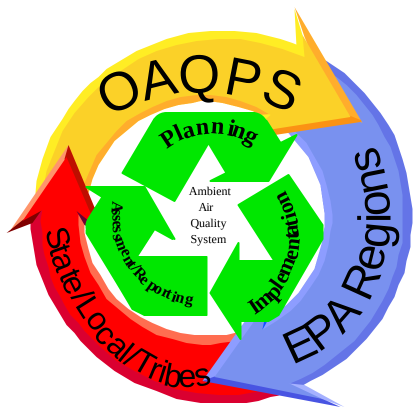
Draft 10-17-01

National Ambient Air Monitoring Strategy



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Section 1. Introduction

1.1 Background and Goal

Monitoring data are a critical part of the nation's air program infrastructure. The nations ambient air monitoring networks inform the public of air quality levels and exposure, establish the compliance status of cities and other areas, track air quality trends and evaluate progress of emission control programs, and support development of emission control and air quality research programs . Monitoring programs, which are operated largely by State and local agencies and Tribal nations, are subject to continual changes in local, state, tribal, federal and academic priorities. New and revised national ambient air quality standards (NAAQS) and other regulatory needs, changing air quality (e.g., general trend toward reduced concentrations of criteria pollutants), and an influx of scientific findings and technological advancements challenge the response capability of the nation's networks. The single-pollutant measuring approach commonly administered in networks is not an optimal design for recent integrated air quality management trends such as the linkages across ozone, fine particulate matter, regional haze, air toxics, and multi-media interactions (e.g., atmospheric deposition). Indeed, the current design of the nation's networks still is based largely on the existing monitoring regulations (Code of Federal Regulations, parts 53 and 58) that were developed in the late 1970's.

The United States spends well over $200 million annually on routine ambient air monitoring programs, and the incentives for growth in ambient monitoring activities generally are clear and compelling and based on scientific findings that lead to revision of air quality standards or identification of important measurement gaps. Less clear is the justification or incentive for divesting in existing monitoring programs. Monitoring programs appear to suffer from inertia once established, and conscious downsizing efforts occur with far less frequency than recent program enhancements (e.g., PAMS, $PM_{2.5}$, air toxics). Stability in networks is a positive attribute, as considerable time spans (decadal length) often are required to detect and interpret important air quality trends. This strategy seeks to achieve an appropriate balance between needed stability and a desired improvement in response capability to scientific finding and emerging priorities. Assuming limited, at best, resource growth in monitoring programs, serious efforts must be devoted to optimizing resources to meet evolving monitoring challenges. The aggregation of so many technical, institutional, and resource issues form the backdrop for an ambient air monitoring strategy.

The goal of the strategy is to manage the nation's air monitoring networks such that critical stable network elements as well as changing priorities can be accommodated within a scientifically sound and resource optimized framework that addresses national and local interests. This framework requires progress on various aspects that shape the monitoring networks, including:

- Establishing an assessment program that supports decision-making steps related to network divestments and investments;

- Developing a communications strategy to explain to all stakeholders the rationale behind network changes and the associated benefits;
- Integrating across programs and organizations to optimize monitoring programs and the utilization of monitoring data;
- Incorporating emerging technological and scientific advances in measurement techniques;
- Reviewing and modifying monitoring regulations;
- Reviewing and modifying quality assurance programs supporting ambient air monitoring;
- Developing a funding strategy that enables the networks to meet their objectives; and
- Developing an adequate EPA technical infrastructure to insure the integrity of data through quality assurance, operations and training support.

The generation of findings and recommendations within this document was guided by the National Monitoring Strategy Committee (NMSC) a group of representatives from EPA, State/local agencies and Tribal nations. The NMSC provided overall direction for this strategy through a series of monthly conference calls and quarterly meeting throughout 2001.

1.2 Scope

This strategy is focused largely on networks administered through the section 103 and 105 Federal Grants programs to State, local agency and Tribal nations, as well as related monitoring conducted by these organizations. These networks commonly are referred to as the National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS) and Photochemical Air Monitoring Stations (PAMS), as well as IMPROVE. This strategy recognizes the leveraging value of a spectrum of other air monitoring efforts, including intensive research oriented studies (NARSTO, PM2.5 Supersites, CRPAQS, PM health centers), deposition monitoring (CASTNET, IADN, NADP) and numerous efforts conducted outside the scope of Section 103 and 105 Federal Grant programs. This admittedly “grey” description of the scope is intended to provide focus and accommodate a tractable product among those parties most closely associated with administering and operating the more routine regulatory based networks, and at the same time consider the value added of related monitoring efforts to assist in
identifying weaknesses and strengths in the nation’s monitoring networks. The apparent limited scope also recognizes peripheral strategic efforts underway such as the air toxics monitoring pilot studies and data analyses projects and the PBT monitoring strategy. These efforts must be coordinated within this national strategy. One can view this current focus on the S/L/T networks as an initial stage that will be succeeded by a more inclusive assessment.

In addition, these objectives are designed to focus on more streamlined networks with the understanding that considerable flexibility (a key operating principle of the strategy) must be provided to these Grantees to address air quality issues that can not be resolved through broad based national approaches. This strategy seeks to foster a balanced operating process that accommodates national and local level monitoring needs.

1.3 Operating Principles

What Are the Key Operating Principles That EPA Will Be Following in the Implementation of a Monitoring Strategy?

Guiding the planning process are a handful of basic principles to be adhered to throughout all monitoring strategy implementation steps. These principles emphasize the active use of data and assessments, strong interactive communications and incorporation of scientific advancements.

1. Partnership: EPA, State, local agencies and Tribes will jointly lead the planning effort underlying this strategy.

2. Flexibility by balancing national and local needs. Network design, divestment, and investment decisions must achieve a balance between prescription (consistency) and flexibility to accommodate national and local monitoring objectives, respectively. We must recognize that localized issues are "national" issues, and nationally consistent data bases serve local (State/Tribe/local agency) interests as well. A national strategy is enhanced by incorporating flexible processes to accommodate a spectrum of local and national objectives. Flexible principles must also be extended to reaching a balance between retaining valued stable network elements and introducing new elements that respond to new priorities.

3. Institutionalize Network assessments. While this document incorporates results of broad based assessment of networks, assessments, especially at the regional level, should be performed on a regular basis to ensure the relevancy and stability of network operations.

4. Demonstrate the value of data. Data should be collected only following defined plans for its use, an associated commitment to objective analysis, and an understanding that collection of data determined to be valueless should be discontinued. A realistic understanding of data usage and patience must be exercised, recognizing that beneficial returns often require several years (e.g., identifying trends) of data collection. Implicit is the understanding that challenges to data usefulness must be answered at a minimum with a defined set of analysis plans and commitments. Clearly, if data do not undergo analysis, or plans for doing so are not available, one can only assume that the data have little or no value.

5. Optimization through integration. Monitoring programs often are administered on a program by program basis, an approach that does not foster active information flow across monitoring components or the development of truly complementary networks. The administration of programs should be in step with our understanding of the scientific and logistical linkages across programs. For example, the developing air toxics program should be considered an integration of existing programs (e.g., PAMS, PM2.5, Sate/local networks) combined with new initiatives. A wealth of complementary monitoring is performed by other federal agencies (and other EPA programs) that support air quality program objectives and, in turn, benefit from the traditional program. Furthermore, several scientific disciplines (health effects, atmospheric processes

6. Effective interfacing with "science." An emphasis should be placed on more active engagement with the scientific community, and its products, recognizing the important role science plays in network design and technology and the role of networks in assisting scientific research. The perspective that a clear demarcation exists between science oriented and agency based monitoring is counterproductive to optimizing the collective value of research and air monitoring. A major cultural change that should be institutionalized is embracing the scientific community as a partner in planning and advice, as opposed to a limited role of critical review.

7. Minimize adverse program impacts. This strategy should maintain integrity of existing agency monitoring programs by emphasizing shifts in programmatic areas (e.g., PAMS to toxics, PM10 to PM coarse/toxics, etc.) and, if necessary, phase in gradual reductions in programs.

1.4 Overview of Strategic process and components.

How do all the elements tie together?

The remainder of this document addresses several operational components of the monitoring strategy. Section 2 focuses on broad based design elements of networks, initiated by defining network objectives and priorities (section 2.1), presenting results from an assessment of the current criteria pollutant networks (section 2.2) and developing a future vision for a more efficient core national network (section 2.3). Section 3 includes proposals for restructuring quality assurance (section 3.1), improving utilization of emerging monitoring technologies using continuous PM monitors as a case example (section 3.2), and modifications of monitoring regulations to accommodate recommendations emerging from sections 2 and 3. Section 4 addresses the timing, resource and communications aspects of this effort.

Most of these components are integrated and often co-dependent on each other as depicted in Figure 1. The basic operating principles (Section 1.3) establish important constraints. First, as a partnership among EPA and States and Tribes, considerable flexibility must be adopted in network design concepts to simultaneously recognize the need for nationally consistent data collection approaches concurrent with tailored localized programs. While certain components of the strategy can be defined as EPA or State/local/Tribe products, the development of all components benefits from input and counsel across all parties. An agreement in principle that establishes a funding split (detailed in Section 4) to support nationally "consistent" and "local/regional" discretionary needs enables a diverse group of stakeholders (the NMSC) to focus on a streamlined and consistent core national network design (Section 2.3), along with more localized networks for States, local agencies and Tribes. Second, the expectation of limited or negligible resource growth demands that the entire system be optimized and the current networks be assessed for redundant or low value sites to remove some of the existing burden to allow for a shift to identified priorities that are not being met. The national and regional assessments (Section 2.2) are conducted to provide broad national targets for reducing the criteria pollutant networks to redirect monitoring resources to stimulate growth in priority areas defined by the NMSC (Section 2.1). For example, the NMSC concluded that expanded continuous PM sampling is a priority to meet future public information needs for air quality index reporting and mapping of PM. The logical resource pool for this activity is the current PM2.5 monitoring budget, where the majority of burden addresses filter based FRM sampling. An assessment of the FRM network should uncover opportunities for reduction (following three years of data collection) to accommodate a shift toward more continuous sampling.

The move toward continuous PM sampling will only be effective with accompanying technical direction and quality assurance (section 4.1 and 4.2) that describes network design objectives and performance specifications for continuous monitors needed to develop confidence in the linkage between established FRMs and continuous technology. Improvements in information management and transfer that emphasize remote data access and satellite support systems are needed as the motivation for increasing capacity for continuous PM monitoring is based on near real time data supply to the public. Investments in automated systems are recommended as a longer term solution to increasing efficiency of monitoring operations. In turn, the assessment results regarding the number of PM FRMs may require modifications of CFR part 58 (section 4.3) which established fairly rigid targets for FRM samplers. Note that the assessments only start with the national effort which are suggested to conducted every 5 years. Ongoing and future regional/local based assessments need to be institutionalized and conducted periodically (e.g., every 2 years) to ensure that the networks are not static and are producing relevant and valued information. Consequently, any modifications in regulations must incorporate sufficient flexibility to accommodate future findings from assessment efforts. Results from the assessment and design activities will require changes in EPA Grant guidance and other tools such as Regional Office Memoranda of Understandings (MOUs), in addition to potential changes in monitoring regulations.

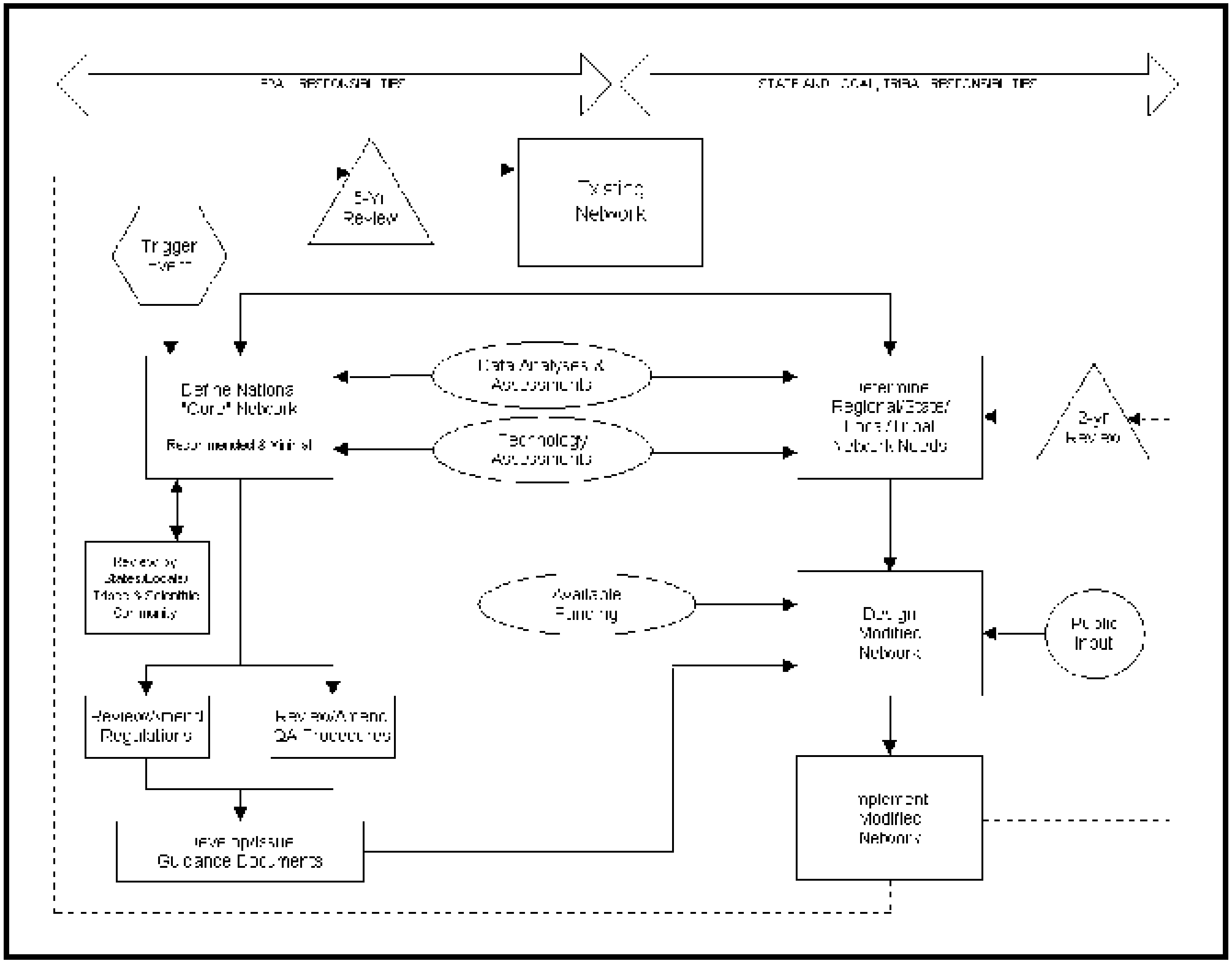

Figure 2. Information flow and integration across strategy elements indicating influence on networks.

1.5 Schedule

The strategy has near and longer term implementation milestones. This document does report on efforts conducted throughout 2001 and includes a schedule of 2001 events that reflect the first phase of this effort. However, this strategy should not be viewed as a final declaration on national air monitoring. More important is the longer range institution of periodic network assessments, the development of quantitative data quality objectives that complement the objective categories and related design elements described in Section 2, and extension to and integration with other monitoring efforts more directed toward research, deposition and multi- media interests.

Phase 1 Product summary:

National network assessments, revision of monitoring objectives and priorities, recommended revisions to monitoring regulations, advanced monitoring implementation plan (emphasis on continuous PM), funding strategy to address recommended changes.

Phase 2 regulations revisions, integration with other monitoring activities, development of network data quality objectives

Table 1. Monitoring Strategy - Phase 1 Timeline Duration of effort (firm)

! Meetings/Group Conference Calls ; **o** Products; (Potential)

Action	Jan 01	Feb 01	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan-June 2002				July
NMSC efforts:	!				!				!	!							
Define objs./priorities						o		o									
Review																	
Core Nat. network des.																	
Strategy report.																	
									o				o				
Report to S/A										o							
Network assessments																	
National																	
Tech. Workshop																	
Regional/local							!										
Technology																	
CASAC PM Mon. Sub	!																
PM cont. Network plan																	
(wkgrp product)								o									
Regulatory Package																	
-WGs formed																	
(EPA/S/L/T)										o							
-pres. to SAMWG												o					
-pro. to SAMWG															o		
-Proposal date target																	
-90-day public comment																	
-Prepare final package																	

Section 2. Network Objectives, Priorities, Design and Assessments

Section 2.1 Network Objectives.

What are the objectives and priorities of the nations's ambient air monitoring networks?

The national network strategy requires a clearly defined set of objectives as a foundation for assessing current networks, establishing monitoring priorities, and to articulate a vision for future direction. Monitoring data provide value to air quality planning, the public and other clients such as the research, academic and industrial communities. This section describes a basic set of objective categories covering these basic needs and assigns relative priorities that indicate directions for network investment and divestment.

Objectives

Ambient data from the regulatory based networks administered through 105 and 103 are address a variety of air quality program needs that include:

- **Compliance:** Comparing air quality data to NAAQS or other benchmarks which drive regulatory actions.

- **Public awareness/population exposure**: Data to support the air quality index (AQI) and AIRNow, and population risk and exposure assessments.

- **Detecting air quality trends and evaluating progress of emissions reduction programs**: Data to detect long term air quality trends and to capture measurable ambient impacts (including emissions precursors and secondarily formed pollutants) associated with emissions reduction programs.

- **Emission strategy development**: Data to support construction of emission reduction programs (e.g., through source apportionment methods, evaluation of air quality models and emission inventories) in support of State Implementation Plans (SIPs), air toxics and environmental welfare/secondary effects programs (e.g., visibility impairment, watershed degradation). Note: This objective although similar is delineated from objective number 3 as the types of monitoring approaches often are specific to the tool (e.g., model) being applied and in many instances emphasis is put on a short term (up to one year) period of data collection to support model application, whereas trends and program evaluation almost always demand a long term data record.

- **Research**: Data to assist research programs (e.g., develop associations between measurements and adverse health indicators, describe physical/chemical atmospheric processes). Note: Research support is not a primary objective of the nation's regulatory networks. However, the regulatory networks provide an important infrastructure that often is leveraged with other research resources that benefit air quality research and eventually regulatory programs.

Data are utilized in a variety of ways to support the objectives listed above, and several examples are provided in Table 1 to clarify the relationship of these objectives to actual data applications.

Table 1. **Listing of common ambient air quality data uses associated major program objectives.**
Obj 1. Compliance with NAAQS and regional haze regulations.
Comparison with National Ambient Air Quality Standards to determine attainment/nonattainment status.
Establishing baseline and progress measures as required by regional haze regulations.
Obj 2. Public information and exposure
Public Information services, for example, reporting timely air quality data to the public (often through air quality indices) with vehicles like AIRNOW, news and weather services, and forecasting (in concert with predicted meteorology) expected high pollution events to warn the public.
Providing data base to associate possible risks related to health benchmarks for hazardous air pollutants and other metrics.
Providing data in response to Environmental Justice and related issues.
Evaluating air quality simulation models that predict concentration fields from emissions, meteorology and chemical/physical process formulations. The predicted concentration fields, in turn, drive exposure models which estimate personal exposure to specific air pollutants. Further, exposure modeling results support risk characterization (e.g., carcinogenic, cardio-pulmonary effects, etc.) of specific populations. In addition, all of the source apportionment and model system related data uses (defining background, transport, EI evaluation) described under objective 2 are applicable.
Obj 3. Trends and emissions reduction program evaluation..
Compiling trends or related information of primary pollutant and precursor species to track progress of emissions reduction strategy implementation. Various data analyses are applied ranging from general trends characterization to exercising observation and emission based models all with the general objective to address the basic question, "Have emission reduction measures been implemented as originally designed, are they effective, and what midcourse corrective steps, if any, are needed?" These applications are responsive to is sues of "accountability" raised in the recent NARSTO (North American Research Strategy for Tropospheric Ozone) critical review, and the related commentary on shortcomings in the SIP process articulated in the National Academy of Sciences (NAS) 1991 report, ***Rethinking the Ozone Problem in Urban and Regional Air Pollution***. Such uses are not limited to criteria pollutants. For example, the IMPROVE network will be utilized as the core indicator to determine effectiveness of regional haze mitigation efforts.

Meeting permitting requirements to ensure maintenance and /or progress toward prescribed impact effects
Measuring important visibility impairing species to measure progress in regional haze.
State of Environment Reports which compile criteria pollutant levels and longer term trends in quarterly in yearly (and longer) data summary reports produced by State agencies, IMPROVE, and EPA's annual Trends Report.
Obj 4. **Development of emission reduction strategies.**
Supporting source-apportionment and other observational based models that largely are driven by ambient data.
Evaluating air quality simulation models that predict concentration fields from emissions, meteorology and chemical/physical process formulations. The air quality model is used explicitly to develop emission control scenarios.
Defining background, regional and transported levels of pollutants that are used to delineate urban and regional pollutant signals, and to develop boundary conditions for air quality simulation models.
Evaluating emission inventories by comparing predicted emissions data with observed concentrations.
To assist in multi-media environmental impact assessments where air concentrations impact watersheds, water bodies, estuaries, soils, etc. Typically, air concentrations are required to estimate deposition loadings into other media as direct inputs into watershed/water quality models that characterize environmental conditions of those media.
Obj 5. Assist research and technical activities in atmospheric science, measurement science, health and environmental effects and exposure.
Testing and evaluation of advanced sampling methods. The phasing of new methods into routine monitoring practices has accelerated due to the rapid pace of technological development and increasing demands and new initiatives placed on the monitoring community. Examples where State and local agencies have been and will be actively engaged in methods testing include the use of continuous gas chromatographs and carbonyl sampling in the PAMS program, the early 1999 start-up period of $PM_{2.5}$ Federal Reference Methods, and the $PM_{2.5}$ speciation sampling program. While programs such as the PM Supersites are intended to assist in transitioning advanced methods to routine applications, the monitoring burden on State and local agencies has increased substantially.

Health effects research support. Although the principal objectives for most air quality data are covered in 1 -3, above, the data simultaneously can support research programs with different objectives. For example, the $PM_{2.5}$ speciation program is designed to address objectives1 and 2; however, modest refinements such as the inclusion of 10 daily sites provide potentially valuable support toward investigating the relationships of exposed populations to specific aerosol components. The more routine data bases such as the 1000 plus $PM_{2.5}$ FRM network provides a potential wealth of information toward continuing investigations associating adverse health impacts and fine mass.
Human Exposure Research Support. Core microenvironment and inhalation data collected in personal exposure research studies is a research activity beyond the scope of routine networks. However, the routine ambient data supplied by networks and other programs (e.g., Supersites, major field studies) provides a critical link from actual exposure through the atmosphere and back to original sources.
Model development and atmospheric process characterization support. Initial testing for developmental models and applied research model efforts require research grade measurements typically beyond the scope of routine programs. By themselves, research grade measurements are not capable of diagnosing model and atmospheric process behavior. The routine data provided by regulatory networks offer an infrastructure of data for advanced model applications which in combination with more advanced measurements offer the potential for comprehensive diagnostic evaluation data sets.

2.1.1 Relationship to existing Section 58 monitoring regulations.

The existing monitoring regulations list a set of objective categories located in the Code of Federal Regulations (CFR) 40 part 58, Appendix D for the State and Local Area Monitoring Stations (SLAMS), of which the National Air Monitoring Stations (NAMS) are considered a subset:

- determine highest concentrations
- determine representative concentrations
- determine impact on ambient levels due to emission sources
- determine regional transport
- determine welfare-related impacts in rural areas

In addition, the CFR lists several objectives for the Photochemical Assessment Stations (PAMS):

- NAAQS attainment and control strategy development
- SIP control strategy evaluation
- Emissions tracking
- Trends
- identifying airshed boundary concentrations
- air quality model evaluation
- ozone and air toxics exposure

These objectives for the combined NAMS/SLAMS/PAMS networks are consistent with those articulated above, illustrating stability and confirmation in the basic uses and purposes of monitoring data. Although consistencies exist between the objectives stated in Section 1.2.1 and the regulations, the revised objectives provide a more tractable and realistic group of expectations that incorporate more recent thinking on monitoring science.

2.2 What are the priorities for current and future networks?

A goal of the strategy is to take account of the current and anticipated needs that are not addressed in existing networks, and assign relative priorities across pollutant and objective categories. Monitoring priorities change over time due to scientific findings and direction from Congressional[1] and EPA Leadership. Current national monitoring program priorities include $PM_{2.5}$ and ozone (including PAMS), based on known and anticipated nonattainment areas. Air toxics is emerging as a national program priority and represents one of several challenges facing the monitoring community. Other priorities of a more localized nature include, for example, responding to public complaints, other criteria pollutant concerns (e.g., CO, SO_2), and specific source-receptor characterization needs. This monitoring strategy is designed to produce a system capable of responding to an evolution of changing program priorities. After developing a concise list of monitoring objectives, priorities will be assigned through consensus discussion among the National Monitoring Strategy Committee (NMSC) members and other outreach efforts guided by the NMSC.

Columns 2-5 in Table 2 provide a listing of general objectives cross referenced by pollutant network. Each objective approached on a single pollutant basis was assigned a relative ranking of high, medium or low with the perspective limited to the relative importance for that specified network. For example, a high weighting for lead monitoring to support compliance signifies the relative importance of meeting this objective in relation to the other four objectives for lead. That high weighting does not reflect an overall priority for lead within the more holistic view of all networks. Column 6 provides an estimate from 1 - 10 of the relative data availability on a national scale and attempts to identify those measurements that are viewed as being extremely scarce (1) to overly abundant (10), and partially supports priority setting across networks in column 7. The priority of a specific network in relation to other networks based on the NMSC's perspective is presented as a sliding scale of 1 - 10 with 1 indicating strongest need for investment. Note that these priorities share some resemblance to the data availability designations in column 6, yet the priorities also consider the NMSC's perspective on what area's regulatory monitoring should engage in. Thus, the NMSC recognizes the shortage of certain process or research oriented measurements, but assumes such activities are beyond the common scope of routine monitoring and rank lower relative to other measurements from an investment perspective. The investment/divestment rankings also do not strictly reflect "importance" as they consider both data availability (column 6) and importance. For example, ozone measurements may be just as/or more important than toxics, however the low data availability and resources in toxics elevate the need for investment.

Table 2. Network Objectives and relative investment priorities across pollutant programs.

	Compliance with respect to NAAQS or haze regs.	Exposure /AQI	Trends and emissions reduction evaluation	Emissions strategy develop ment	Research support	Data[1] availability /need <u>1 - 10</u> 3=minimum acceptable 5=desired	Priority for investment and divestment 1 - invest 10 - divest (generally not applicable to Tribes)
	Values H, M, L reflect relative importance of each objective within given network, and do not signify relative priority across networks					note:	
Ozone and related species							
ozone	H	H	H	H	M	5	5
PAMS: O3 precursors (N)	L	L	H	H	M	7	7
PAMS: O3 precursors (VOC)	L	L	H	H	M	7	8
T high sens CO	L	L	M	M	M	1	4.5
T NOy	L	L	H	H	H	1	4
T chemical process parameters (NO2, H2O2, OH)	L	L	L	H	H	1	5
PM and related precursors							
PM2.5 FRM	H	M	H	M	M	8	8
PM cont. mass	M	H	H	H	H	2	3
PM2.5 spec	L	M	H	H	H	5	5
PM10 mass	M	M	H	M	L	8	8
T PM coarse	L	M	L	L	H	1	4

Table 2. Network Objectives and relative investment priorities across pollutant programs.							
T PM size dist.	L	L	L	M	H	1	5
T PM 2.5 precur HNO3, NH3, SO2	L	L	M	H	H	1	6
Remaining criteria pollutants							
regulatory CO	H	L	M	L	L	8	9
reg NO2(NO)	H	L	L	L	L	9	9
reg SO2	H	M	L	L	L	8	9
Pb	H	L	L	L	L	8	9
Toxics							
T volatile	L	H	H	M	H	2	2
T SVOCs	L	H	H	M	H	2	2
T metals	L	H	H	M*	H	2	2
T PBTs	L	H	H	M	H	2	2
Miscellaneous							
Acid/N deposition (CASTNET)	L	L	H	M	M	5	5
visibility (camera)	H	M	H	M	L	5	5
meteorology	L	L	L	H	H	5	5
1 low values a perceived shortage of data **2 low values indicate a recommendation to invest based on a perceived shortage of data and appropriateness for “routine” networks** **notes: T yet to be developed or preliminary stage** *** rated H for mercury**							

2.2.1 Developing Network Data Quality Objectives to drive a fundamental network design

The set of network objective categories discussed in Section 2 and prioritized by the NMSC provide directional guidance for network assessment described in section 3. This largely qualitative, consensus building approach undertaken by the NMSC should be balanced by the development of quantifiable objectives that in turn can form the basis for a national network design as alluded to in section 4. Developing network data quality objectives (DQO's) which quantify the degree of measurement accuracy (statistically in terms of precision and bias) in spatial, temporal and compositional components terms is a challenging task given the myriad of interests among stakeholders and monitoring agencies (~ 300 monitoring agencies and sevearl hundred Tribal nations). This topic is addressed in Section 4 within the context of national scale network design considerations.