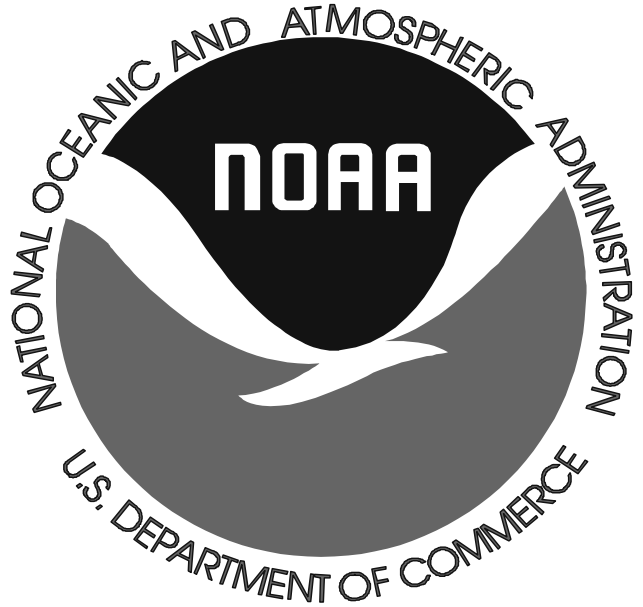
# COOP Modernization: Building The National Cooperative Mesonet

# Program Development Plan
## March 2004




**U.S. Department of Commerce**
**National Oceanic and Atmospheric Administration**
**National Weather Service**

# Building
# The National Cooperative Mesonet

# Program Development Plan
# For
# COOP Modernization

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## *Signature/Approval Page*

**National Weather Service**
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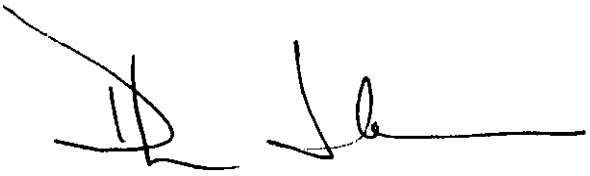
Approved:  Date: 5/31/2004

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**National Weather Service**

# *Executive Summary*

The modernization of the Cooperative Observer Network (COOP), managed and maintained by the National Oceanic and Atmospheric Administration (NOAA) and its National Weather Service (NWS), *will result in building the National Cooperative Mesonet* (NCM). The NCM will integrate and quality assure observations from a wide array of surface-observing systems that monitor the weather, water, and climate variability across the United States. In effect, *the NCM will become a "network of networks"*. This cross-agency program for the nation will be expandable and adaptable to meet the current and future needs of NOAA and its many public and private sector partners.

The vision for the program to modernize the COOP network is to:

> Be a modern network that can *serve the nation as the backbone of the National Cooperative Mesonet and the sustaining factor around which all surface environmental monitoring networks are integrated* to save lives, enhance national security, protect property, support transportation, energy and agriculture, and promote the economic well-being by providing the highest-quality possible of real-time weather, water, and climate information, and possibly air quality and biochemical hazard data.

The need to modernize the COOP network results from an exponential increase in the new applications of COOP data. Unfortunately, data from the COOP network are cumbersome to access because the network uses sensor technology that is dated and not automated. More importantly, the need is based on the fact that the *"current COOP network cannot be sustained [or improved] at present funding levels"* (NRC 1998; National Research Council). Hence, the COOP network must be revived with the technology and funding necessary to serve the nation in the 21st century. In addition, the NRC (2003) recommended *"one central focal point for coordinating the real-time acquisition and quality assurance of data from these [many] networks."* As the backbone for the nation's surface observing networks, the NCM will be the best central focal point for these tasks.

### One Important Opinion

"The Cooperative Observing Modernization Program has been proposed as a new initiative within NOAA for over a decade, but with little success. Without the required investment, the program is in danger of becoming unreliable for local climate monitoring, a key strategy for mitigating climate impacts and risks, and for maximizing climate opportunities. Today, the stations have antiquated equipment, maintenance is unable to keep pace, and the observations are becoming more questionable by all users. With more than a 100-year legacy and recommendations for a fully modernized network by many groups (including our own National Research Council), the nation cannot afford to squander this national treasure. Maintaining the old network is in serious jeopardy, and is now going past the stage of no return where climate records will soon be irrevocably lost due to an antiquated observing system. This situation is most unfortunate as other networks, such as the more coarsely-spaced Climate Reference

Network, are counting on a robust high-density surface observing network to define national, regional, and local climate variations and changes."[1]

The modernized COOP and the subsequent building of the National Cooperative Mesonet are appropriate responses to:

- Earth Observation Summit, which proposes to establish an international, comprehensive, integrated, and sustained Earth Observation System (EOS)
- NOAA, which proposes to establish a foundation for surface and hydrological observations in its Observing Systems Architecture
- NOAA, with a new Strategic Vision and priorities for the 21st century, proposes three strategic goals:
    - Mission Goal 2: Understand climate variability and change to enhance society's ability to plan and respond
    - Mission Goal 3: Serve society's needs for weather and water information
    - Mission Goal 4: Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation
- Senate Bill 1454, which proposes to establish a National Drought Council with the U. S. Department of Commerce named as the lead agency for the purpose of implementing a national drought monitoring network

Thus, *the requirement to modernize the COOP network and build the National Cooperative Mesonet* derives from the fact that the proposed surface-observing network is an essential tool to help meet the three Mission Goals. This Program Development Plan and the integrated, quality-assured surface observations it will produce also represent the first component of the U.S. contribution to the EOS and is an answer to the many calls from the professional and scientific communities for improved surface observations. The resulting infrastructure should serve the nation well because improved drought monitoring (e.g., soil moisture) and improved transportation weather (e.g., road surface temperatures) are critical needs whose solutions are within reach. The vast economic dividends from establishing a National Cooperative Mesonet are unquestioned (Appendix A).

*The scope of the COOP modernization* will produce the following deliverables:

- Many modernized COOP stations with high-quality sensors and observing standards that are maintained at accepted professional levels

[1] Personal Communication from Dr. Tom Karl, Director of the National Climatic Data Center (July 2003). Used with permission.

- A contract, based on requirements within the Functional Requirements Document (FRD), that is established for the acquisition, installation and maintenance of automated NWS sites in the modernized COOP
- An integrated surface network — *termed the National Cooperative Mesonet* — that is expandable and adaptable to meet future observing needs and requirements
- Rigorous quality assurance of network data that are made available in real time through a distributed network of mirrored servers validated by professional staff at an operations monitoring facility who have been specially trained in data quality assurance
- A modernized COOP system that provides 5-minute observations transmitted at hourly intervals with a goal for transmission at 15-minute intervals to better sync with WSR-88D scans and to provide initialization and verification data for evolving asynoptic models and the new products from numerical weather prediction (NWP)
- Mesoscale data for public and private sector applications in NWP
- Opportunities for the private sector to develop thousands of value-added products and applications
- An NWS emphasis on partnering with the public and private sector
- *A new legacy of providing open and accurate mesoscale data that are reliably available in real time*

In its essence, the modernized COOP network will be composed of two types of automated sites: baseline sites and enhanced sites. The measurements at each of these site types are summarized in the table below:

| **Variables for Baseline/Enhanced Sites** |
|---|
| **Measurements at Baseline Sites** |
| Air Temperature (1.5 m) |
| Precipitation (0.6 m) |
| |
| **Measurements at Enhanced Sites** |
| Air Temperature (1.5 m) |
| Precipitation (0.6 m) |
| *Plus possible sensors to measure:* |
| Air Quality and Biochemical |
| Atmospheric Pressure |
| Incoming Solar Radiation (1.8 m) |
| Relative Humidity (1.5 m) |
| Soil Moisture (several depths) |
| Soil Temperature (several depths) |
| Wind Speed and Direction (2 m and 10 m) |
| Other New Sensors |

A *critical component* of the modernized COOP will be the *establishment of a Central Facility* that operates on an around-the-clock basis to produce real-time access to quality assured data.

The resources required for the Central Facility will be partially offset by improved efficiencies in the management and maintenance of the modernized COOP. The COOP's Central Facility also will have a capability to quality assure data from a diverse set of observing platforms and to integrate all data into a composite that represents the fruits of building the National Cooperative Mesonet. All components will be Commercial Off-The-Shelf (COTS) technology.

The *key ingredients* of the modernized COOP will be its *adherence to high standards and to the accessibility and timeliness of its data*. Through the COOP's Central Facility, the National Cooperative Mesonet will *ingest and integrate as many complementary measurements as possible from other networks* (both federal and non-federal) — including data from state transportation weather networks, urban micronets, and networks still on the horizon. As a result, many NWS mission requirements are aligned with the COOP modernization.

A Program Office will be established to lead the acquisition and implementation of the modernized COOP. The Program Office also will *assume the end-to-end responsibility* for the COOP Program, from testing and acquisition of the modernized technology to its long-term maintenance to helping design a concept of operations for the National Cooperative Mesonet to overseeing the integration of thousands of surface observations into the National Cooperative Mesonet. Finally, the Program Office will have a responsibility to oversee the joint operations of the traditional COOP and the modernized COOP as automated sites are commissioned.

All phases of the COOP modernization are being designed for completion within five (5) years after the modernization begins *to reduce the risk that the continuity of the modernization will be compromised and to reduce the costs associated with operating and maintaining dual COOP networks*.

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# 1 — Introduction

## 1.1 Purpose and Scope of this Document

This document provides the framework and guiding principles for the modernization of the Cooperative Observer Network, sponsored by the National Oceanic and Atmospheric Administration (NOAA) and its National Weather Service (NWS). The modernization program has three aligned goals: (1) to automate the technology used in the COOP network; (2) to establish a high-quality infrastructure to integrate surface observations from a wide range of platforms; and (3) to build *the National Cooperative Mesonet*. The purposes of this Program Development Plan (PDP) are to:

- Document the vision and objectives for the program to modernize the COOP program
- Provide the top-level acquisition and implementation plan that describes the overall scope and management approach for the modernization program
- Identify key decision points and checkpoints for effective management control
- Outline a concept of operation for modernized (automated) COOP sites, the National Cooperative Mesonet, and the traditional COOP sites

The scope of this document is limited to the acquisition functions necessary to *define, acquire, implement, and establish a modern capability for the long-term operation and maintenance of the modernized COOP network and the subsequent building of the National Cooperative Mesonet*. Future enhancements to the modernized COOP are not addressed other than to note that the system design is to be modular and expandable to incorporate new sensors made possible by new requirements from NOAA and by the requirements and support of partner agencies.

This PDP will be updated and reissued as changes occur in the program direction or its scope. Section 1 presents an overview of the mission need for a modernized COOP network, its objectives and scope. Section 2 describes the infrastructure designed to support the modernized COOP and the National Cooperative Mesonet. Program acquisition and scheduling are described in Section 3. Section 4 describes the management of system acquisition while Section 5 overviews the components in an operational but modernized COOP.

A list of abbreviations and acronyms are in Appendix K.

## 1.2 Background of Needs for the COOP Network

The COOP network is a nationwide weather, water, and climate-monitoring network of volunteer citizens and institutions that observe and report weather information on a regular basis. Other government agencies participate in the program by providing funds and equipment. The network consists of more than 11,000 stations, the majority of which report daily maximum and minimum temperatures and precipitation totals. The roots of the network extend to 1870 and the Army Signal Corps, which collected weather and climate information for use in military operations. Because the data were subsequently found to be more useful for agriculture, the network was transferred to the USDA along with the Weather Bureau in 1890. Yet, applications of COOP

data in today's information-based society have flourished to influence all sectors of the nation's economy.

However, the program has not kept pace with these growing demands or with current technology. Processing of the data is labor intensive and does not occur in real time. Quality control and archiving of COOP data are cumbersome and inefficient. The basic observing equipment is, for the most part, unchanged since the program's inception. While the data does meet the most basic demands, the COOP system does not meet the expanded needs of the modern world.

## *1.3 The View of the Scientific Community*

The National Research Council conducted an extensive review of the Cooperative Observer Network in 1998 and concluded:

> Despite its increasing importance to the nation, over the past several years the COOP Network has been weakened by a combination of technological, organizational, and budgetary factors. … *The current COOP Network cannot be sustained [or improved] at present funding levels*[2].

The NRC Panel made the following recommendations (among others):

- A multilevel network that is upgraded according to three main priorities:

  1. Maintain a network size and density that satisfies all major needs;
  2. Ensure that the quality of the data remains high; and
  3. Make a large subset of the data available faster — preferably on a near-real-time basis.

- Standards for the instruments and siting must be maintained.

- NOAA has an opportunity to build a modern system that can play an integral role in the nation's weather and climate information networks and to enhance the role the network already plays in matters relating to the health, safety, economic concerns, and general well being of the nation.

In one of its most recent studies[3], the NRC (2003) determined:

> With the increasing number of regions establishing mesonet systems, *it would be useful to have one central focal point* for coordinating the real-time acquisition and quality assurance of data from these networks. The current array of surface observation systems needs to be better used and enhanced. … [because] it is often difficult to obtain the data from multiple observational arrays, especially in real time.

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[2] *Future of the National Weather Service Cooperative Observer Network*; National Research Council, 1998

[3] *Tracking and Predicting the Atmospheric Dispersion of Hazardous Material Releases — Implications For Homeland Security*; National Research Council, 2003

The rapid expansion in the use of climate data and information for a wide variety of applications (Changnon and Kunkel 1999) further demonstrates the societal needs for a National Cooperative Mesonet. In addition, the academic community listed the "operational, maintenance, and improvement of the national atmospheric observation and prediction systems" as *its highest priority for NOAA and the NWS* to undertake (Dutton et al. 1998). Unfortunately, "COOP data is the forgotten stepchild of surface data" [comments by John McLaughlin, 2002 President of the National Weather Association during a COOP Partners' Forum in September 2002].

The widespread and growing use of COOP data also was noted by the NRC (1998):

> … the applications of the data have expanded dramatically. Data from the network are now used in many ways, ranging from the management of water resources and the design and maintenance of infrastructure to predictions of crop yield and local weather forecasting. The data provided by cooperative observers are used in a myriad of important political and economic decisions all across the country by private industry, all levels of government, and private individuals.

Finally, Dr. Tom Karl, Director of the National Climatic Data Center (NCDC), lamented in July 2003 (personal communication — used with permission) that the *"COOP modernization is now going past critical. We need to make a major effort and push on this again. It continues to be a national embarrassment."*

Thus, *the requirement to modernize the COOP network and build the National Cooperative Mesonet* derives from the fact that the proposed surface-observing network is an essential tool to help meet three Mission Goals of NOAA. This Program Development Plan and the integrated, quality-assured surface observations it will produce also represent the first component of the U.S. contribution to the EOS and is an answer to the many calls from the professional and scientific communities for improved surface observations. The vast economic dividends from doing so are unquestioned (Appendix A).

The path to this new Program Development Plan was paved through the 'labor of love' from numerous individuals during the past 12-15 years. While the current plan replaces a COOP modernization plan endorsed by the Director of the NWS in 1993, it draws heavily from that early plan (NOAA/NWS 1993).

## *1.4 Vision for an Integrated Surface Observing System and the National Cooperative Mesonet*

As illustrated in Figure 1, the COOP modernization program will:

> Be a modern network that can *serve the nation as the backbone of the National Cooperative Mesonet and the sustaining factor around which all surface environmental monitoring networks are integrated* to save lives, enhance national security, protect property, support transportation, energy and agriculture, and promote the economic well-being by providing the highest-quality possible of real-time weather, water, and climate information, and possibly air quality and biochemical hazard data.

In effect, the National Cooperative Mesonet will become *a "network of networks."*

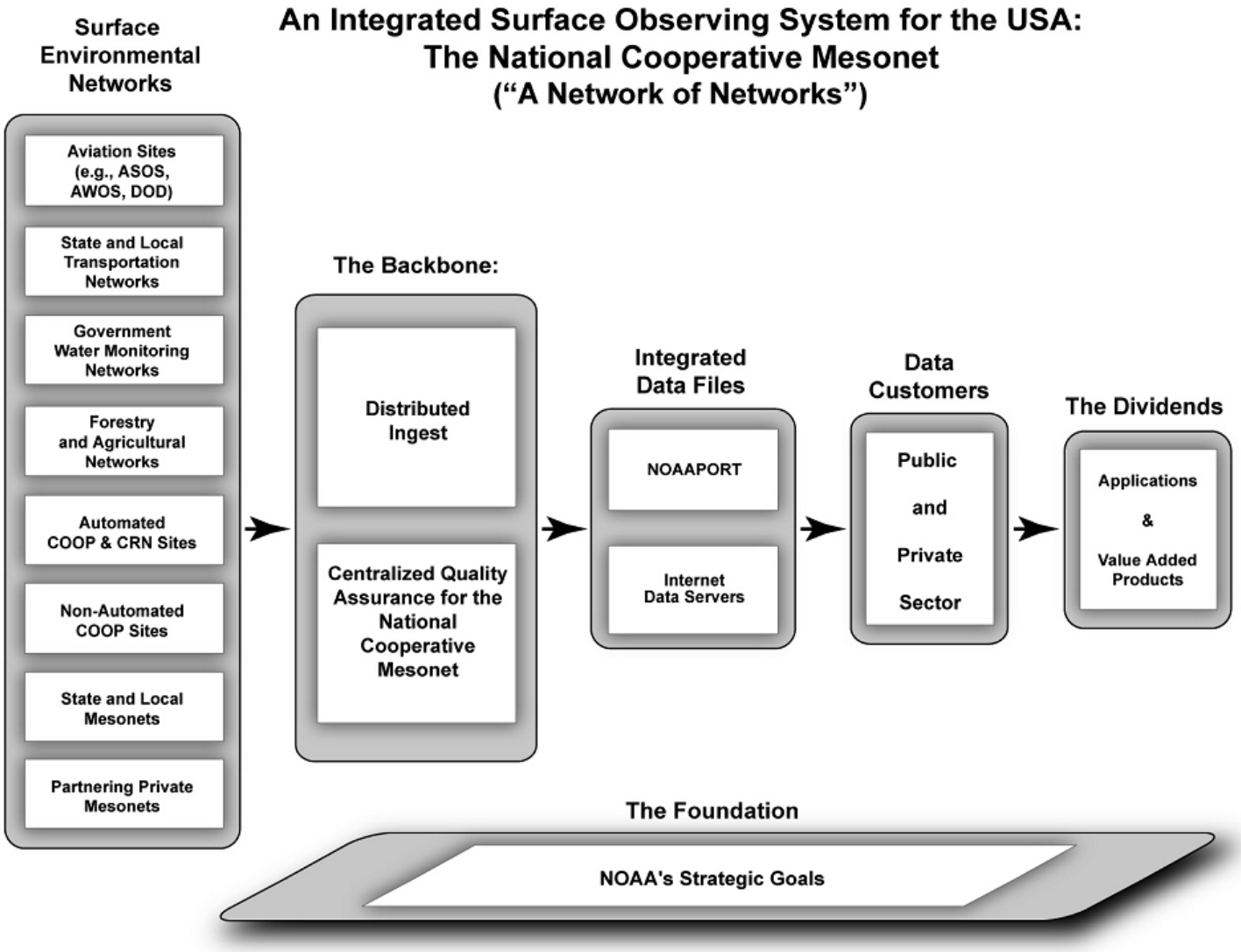


*Figure 1. The vision for an integrated surface observing system*

## *1.5 Scope of COOP Modernization — To Build A National Cooperative Mesonet*

The scope of COOP modernization will produce the following deliverables:

- Consist of many modernized stations with high quality sensors that are sited and maintained at accepted professional levels and follow the accepted principles of climate monitoring (Karl et al. 1995; NRC 1999). See Appendix E.2 for details.

- Produce a contract, based on requirements within the Functional Requirements Document, for the acquisition, installation, and maintenance of automated NWS sites in the modernized COOP

- Develop an integrated network — *termed the National Cooperative Mesonet* — that is expandable and adaptable to meet future observing needs and requirements. In the end, a "network of networks" will have been produced.

- Provide rigorous quality assurance of network data that are made available in real time through a single operations monitoring facility — to prevent 'bad' data (i.e., data that fail quality assurance procedures) from going public and to assist the national Program Manager with oversight of network operations (Section 5.4; Appendix D; Figures 3 & 6). In essence, reliable data needs to be reliably available.

- Provide 5-minute observations transmitted at hourly intervals with a goal for transmission at 15-minute intervals to better synchronize with WSR-88D scans and to provide initialization and verification data for evolving asynoptic models and the new products from numerical weather prediction (NWP).

- Provide mesoscale data for public and private sector applications in NWP

- Provide opportunities for the private sector to develop thousands of value-added products and applications

- Emphasize NWS partnering with the public, private and academic sectors

- Create a legacy of providing open and accurate mesoscale data that are reliably available in real time and, in the end, meet the operational weather, water and climate needs of NOAA and the NWS

# 2 — System Description

## 2.1 Introduction

The design of the modernized COOP network and the National Cooperative Mesonet it will produce features flexibility and expandability. The design will use a structured program management, and the resources and knowledge of public and private sector partners of the NWS. A mix of the most cost-effective site upgrades will be implemented to create a successful design that is as independent of budget fluctuations as possible. Regardless, the design of the modernized COOP network shall be as robust as possible so as to survive any eventuality.

The optimal integration of resources through strong partnerships is necessary to meet the vision for the COOP modernization and to build the National Cooperative Mesonet. Even so, *the quality of data produced by the modernized COOP network must not be compromised or fall below accepted standards*. The scope of the modernization program requires a multi-year period of adequate funding whose length depends on available resources from year-to-year. These capital resources will come from budget initiatives of the NWS and its Government partners, and from the available resources of the Government and its private partners.

This plan is written from the perspective that automation of the traditional COOP is complete ~5 years after modernization begins *to reduce the risk that the continuity of the modernization will be compromised and to reduce the costs associated with operating and maintaining dual COOP networks*. Alternative implementation strategies and their impact on the mission and strategic goals of NOAA and the NWS are described in Appendix G. A potential implementation strategy that places heavy emphasis on partnering and cost sharing with key agencies in the 50 states is outlined briefly in Appendix H.

## 2.2 Spatial Density of Sites in the Modernized COOP Network

The required spatial density of sites in the modernized COOP was defined by the NWS and by the National Climatic Data Center (NCDC). Based on many competing factors, their review (Del Greco et al. 2000; Del Greco and Smith 2002) recommended a spatial density of one COOP site within each 20 nautical mile by 20 nautical mile grid square. Many respected meteorologists and climatologists also endorse the recommended density as appropriate for the modernized COOP.

Based upon the geographic area of the contiguous United States (~3 million square miles minus the areas of major lakes and otherwise inaccessible land areas) and the recommendation to place one modernized COOP site every 400 square miles, the modernized COOP network will require automated monitoring equipment at ~7500 sites. Because of rugged terrain and large wilderness areas, ~500 automated COOP sites are recommended for Alaska and Hawaii.

Thus, about 8000 sites are required in the modernized COOP network — subject to operational, budgetary, and socio-geographical limitations. *Traditional sites deemed necessary to maintain the continuity of climate records that are not automated will continue to report in their current mode and will be maintained by the staff at WFOs.*

This network spacing (density) will help the NWS meets the following mission requirements and strategic goals:

- Improved accuracy of sub-county level forecasts and warning products
- Improved verification information for the next generation of storm-scale numerical weather prediction models and the next generation of MOS guidance (Model Output Statistics)
- Improved real-time river modeling and basin calibration along with improved flood and drought monitoring
- Significant reduction in the real-time biases that accompany radar estimates of precipitation
- Improved grid analyses of precipitation and temperature, which are essential to realize the potential of the gridded forecast environment and to link climate monitoring and prediction products with societal trends

## *2.3 Concept of Data Collection at a Remote COOP Site*

The modernized COOP network will be composed of *two types of automated observing sites*. All automated sites will provide **the current baseline measurements** of air temperature and precipitation. Some sites will provide the baseline measurements and **enhanced measurements** such as wind speed and direction, solar radiation, soil temperature and soil moisture, air quality, biochemical data, and road weather data (see Table 1 for details).

***Table 1. Measurements at an Automated COOP Site***

| Variables for Baseline/Enhanced Sites |
|---|
| **Measurements at Baseline Sites** |
| Air Temperature (1.5 m) |
| Precipitation (0.6 m) |
| |
| **Measurements at Enhanced Sites** |
| Air Temperature (1.5 m) |
| Precipitation (0.6 m) |
| *Plus possible sensors to measure:* |
| Air Quality and Biochemical |
| Atmospheric Pressure |
| Incoming Solar Radiation (1.8 m) |
| Relative Humidity (1.5 m) |
| Soil Moisture (several depths) |
| Soil Temperature (several depths) |
| Wind Speed and Direction (2 m and 10 m) |
| Other New Sensors |

Other sensors might include a nationwide array of differential global positioning systems (NDGPS; see partnership roles in Appendix C) to measure the precipitable water in a column

above each COOP site, an array of low-cost radars specially designed to measure phenomena in the planetary boundary layer, sensors to measure the surface fluxes of sensible and latent heat, or the capability to acquire surface data from sensors specially mounted on public safety vehicles (i.e., the surface equivalent of ACARS).

The infrastructure of the modernized COOP network and the National Cooperative Mesonet should be capable of adding new sites beyond the initial base density requirement if desired by a cooperator (e.g., in major metropolitan areas to support air quality, homeland security and transportation issues or to support short-term rapid deployment during situations when environmental monitoring is needed to facilitate recovery following a biochemical event.

While the modernized COOP network will be designed to accommodate future growth, *the initial baseline sensors do not include the modernization of COOP stream gages. This initial design decision is driven completely by funds likely to be available.* Even so, the design of the modernized COOP shall be as robust as possible so as to survive any eventuality (such as an initial national contractor failing to meet the ongoing standards set for COOP modernization).

Human observers will continue to be a valued component in the modernized COOP network, though their function may change with time. Until the manual observations of the liquid-water equivalent of frozen precipitation, the 24-hour snowfall, and snow depth can be automated, human observations are indispensable (Figure 2). At some automated sites, the human observer may provide more frequent measurements of snow depth. At other automated sites, a human observer may not be present. Regardless, a backup precipitation gauge is not planned for any site. Instead, automation of these manual elements will be a goal of the new Program Office.

Sites chosen for an enhanced array of sensors will be based on requirements developed within NOAA and/or the requirements/support from the NOAA partners listed in Appendix C. In addition, through the COOP's Central Facility, *as many complementary measurements as possible will be ingested and integrated with data from other networks* (federal and non-federal).

The modernized COOP network is required to be a modular system to support future expansion and evolving needs. While the modernized network may produce environmental data for research purposes, the modernized COOP network *will function as an operational system* and will, so far as is practical, acquire quality data for the weather, water, and climate communities. Thus, the modernized network is required to operate continuously, reliably, and with a high operational availability over the full range of environmental conditions across the United States. The system will be *required to adapt* to different:

1. **Sets of Variables —** for expansion in response to evolving agency requirements

2. **Sensors —** to incorporate improved sensors/data loggers, either as new techniques and technologies are developed or as broken sensors are replaced via Commercial Off-The-Shelf (COTS) sensors.

3. **Communications** — to accommodate new and evolving technologies

The concept of data collection and transmission at NWS sites in the National Cooperative Mesonet is illustrated in Figure 2.

## 2.4 Requirements for the COOP Modernization

The modernized COOP network is required to monitor the weather, water, and climate variability of the United States, provide high-resolution and precise real-time data for operational warnings, forecasts and their verification, provide data for use in evolving asynoptic numerical weather prediction and climatic models, and protect the continuity of the climate data records. The network will be expandable to meet future observational requirements and will collect data with at least a 5-minute time resolution. Data are to be transmitted at least hourly with a goal of 15-minute transmission intervals.

The Functional Requirements Document for COOP Modernization Program (also known as *Building the National Cooperative Mesonet*) provides the technical requirements of NOAA and its partners for sensor performance, siting, installation, data quality assurance, and maintenance. The requirements in the FRD will be approved by NOAA and its partners and constitute the Site Standards for the modernized COOP network (Appendix E). *A contract, based on the requirements within the FRD, will be established for the acquisition, installation, maintenance and long-term operation of automated NWS sites within the modernized COOP.*

An overview of system operations for the COOP portion of the National Cooperative Mesonet is shown in Figure 3.

## 2.5 Categories of Observing Sites in the Modernized COOP

Within the two sensor configurations (baseline and enhanced), four (4) categories of observing sites will exist in the modernized COOP network:

1. **Category-1** — New COOP Sites: A contractor will install and maintain the new automated equipment, which meets the site, sensor, and observing standards established for the modernized COOP (i.e., WMO [World Meteorological Organization] and NWS standards; listed in Appendix E and in the FRD).

2. **Category-2** — Current COOP Sites: A contractor will replace and maintain the new automated equipment, which meets the site, sensor, and observing standards established for the modernized COOP (i.e., WMO and NWS standards; listed in Appendix E and in the FRD).

3. **Category-3** — Sites With Non-NWS Equipment: These existing sites are owned by a variety of partners who operate observing *platforms that fulfill a spatial requirement of the COOP Modernization Program* (e.g., a CRN site).

   These sites must meet the established WMO/NWS standards for siting, sensor performance (Appendix E and the FRD), data availability, data quality, routine maintenance, and required metadata (Appendix D).

   All equipment is installed and maintained by the platform owner/COOP partner.

   Selection criteria include length of station history and variety of data types, but temperature and precipitation represent the minimum threshold. If the annual performance of a Category-3 site drops below COOP standards, the Program Manager for the

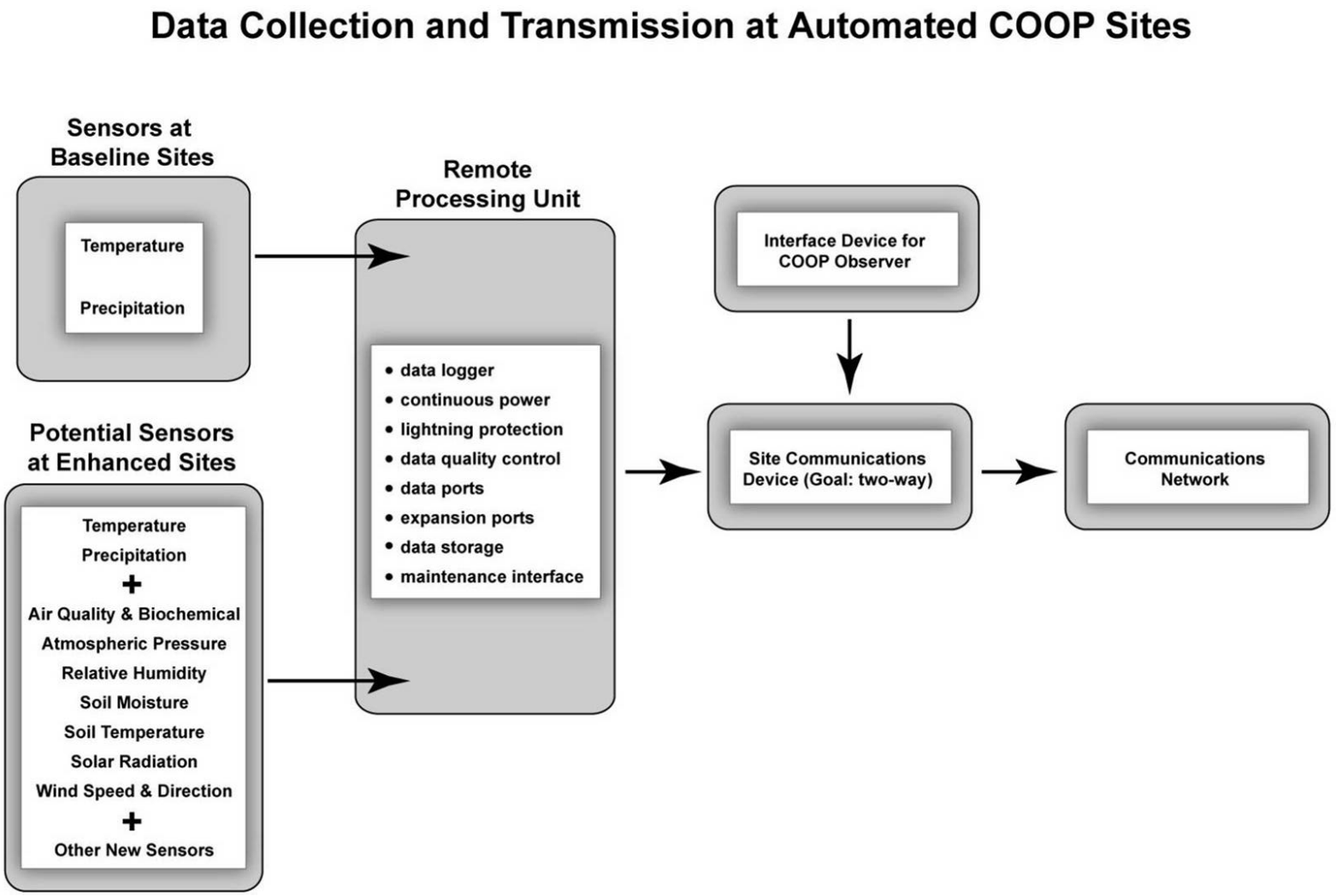


***Figure 2. Data collection and transmission at automated COOP sites***

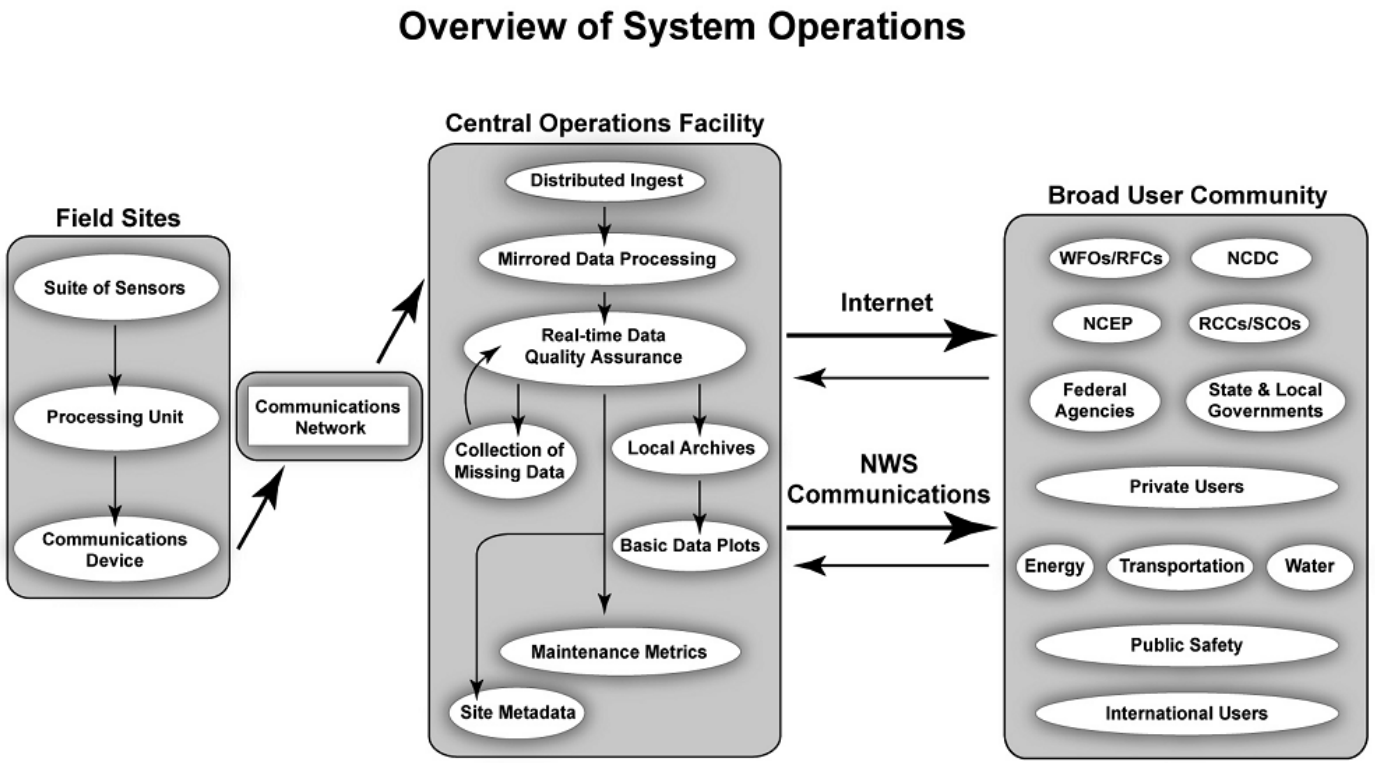


***Figure 3. System operation for the COOP portion of the National Cooperative Mesonet***

Modernized COOP will propose corrective action that must be addressed for the site to continue as part of the modernized COOP.

- Some non-NWS sites proposed for inclusion in the modernized COOP network may require support for partial upgrades of the resident sensors or its communications equipment to meet the established standards. The COOP modernization program may provide the resources for these upgrades. Requests for these resources should come from the regional teams to the COOP Configuration Control Board (Section 4.4).

- *Quality-based support incentives from NOAA are one means to attain climate-quality data from non-federal observing platforms.*

- *Memoranda-of-Agreement will be developed to define clearly the contributions or exchanges between the Government and COOP partners (examples in Appendix I).*

4. **Category-4** — Existing COOP Sites Not Selected for Automation: These sites will be selected based upon the extent and quality of the long-term data records (or the lack thereof). Preference will be given to sites with long-term high-quality data records that are not otherwise needed to fulfill the automated portion of the modernized COOP network; they will be supported by the NWS (i.e., the WFOs) as traditional COOP sites.

   Sites whose relocation would severely compromise the ability to detect climate change signals in a region — even only short distances — may be maintained as Category-4 sites. To the extent possible, observers at Category-4 sites will report their manual observations through automated means, such as an Internet/web-based interface. These traditional sites also will continue to report their current suite of observations. Sites with long-term, high-quality, and continuous records that fall within a grid box already covered by another automated site may be maintained as a Category-4 site for the purpose of maintaining critical observations for climate assessment.

   The future of Category 4 sites will be based on recommendations from the Regional Site Selection Teams and the availability of funds for their maintenance and operation. In many cases, some difficult decisions may have to be made and those decisions begin with deliberations by the Regional Site Selection Teams.

   *A traditional COOP site could meet all siting standards and still become a Category-4 site due to the requirement to place only one automated site in each 20 mile grid square*

Other observing sites not needed to meet the required station density (Section 2.2) for the modernized COOP network or traditional COOP sites whose siting and observing standards fall below those established for the modernized COOP (i.e., they are improperly sited) will become *complementary additions to the integrated surface observing and data processing system of the National Cooperative Mesonet* (Figure 1). The same holds true for the many other automated networks that exists across the United States (e.g., local Mesonets, micronets, state transportation networks, etc.). However, the Central Facility will have a capability to accommodate privileged access to and distribution of data that a cooperator may wish to hold as privileged (e.g., lightning data, Canadian data, transportation weather observations, etc.).

Equipment recovered from Category-2 sites will be reconditioned at the NWS Reconditioning Center to support the Category-4 sites.

## *2.6 Details About The Data*

The data logger at each remote site in the modernized COOP network will have a capability to store a significant quantity of data (~2-3 months). When communications problems develop, the missing data will be retrieved at the first opportunity — either when two-way communications are re-established or when maintenance personnel are on-site. The late-arriving (hence missing) data will be entered into the local archives at the Central Facility in the most expeditious manner possible for transmission to system users.

The format of COOP data from automated sites will be approved by the COOP's Configuration Control Board (CCCB). This format will be based on all options, but the format shall be as simple and as practical as possible. However, the Government may specify a data format such as SHEF or BUFR or a more modern format such as XML.

The technology used to ingest automated COOP data into a distributed network of servers for access by the Central Facility will be determined by the COOP Steering Committee (CSC; Section 5.2) based on options provided by the CCCB (Section 4.4). The COOP Contractor will provide recommendations to the CCCB through the COOP Modernization and Acquisition Program Manager (Section 4.3) for the methods of data transmission from each automated site. NOAA and its partners should investigate cost-effective methods of data transmission that leverage existing (state and national) communication systems and recommend options to the CCCB. *Two-way communications is a goal* for automated COOP sites in the National Cooperative Mesonet, though multiple solutions for telecommunications may result. Regardless of the solutions, COTS technology will be used.

The acquisition and processing of automated COOP data will evolve with time and technological changes as will the procedures for data-quality assurance and quality control (QA/QC; Appendix D) at the Central Operations and Monitoring Facility (Section 5.4). The constant requirement is to acquire, process, quality assure, and disseminate data from the automated COOP network and the National Cooperative Mesonet in real time (Figure 3) so as *to avoid single points of failure* in accessing network data. In this context, 'real time' means that the integrated data sets become available ~10 minutes after they arrived at the Central Facility (e.g., data are reliably available ~10 minutes after the hour when the data collection period ended at the hour).

In addition, *data transmitted from the Central Facility will identify the platform owner and will have a QA flag that accompanies <u>each</u> datum*. It is important to note that *<u>original data must never be altered</u>*. The techniques and technology used for data ingest, processing and automated QA will be outlined in a 'concept of operations' plan that is separate from the modernization plan (see Section 4.10).

*<u>At the discretion of NCDC, all COOP data will be reprocessed with enhanced QA/QC routines as they enter the national archives.</u>* Note Figures 3, 5, and 6 and Appendix D.

## 2.7 Protecting the Continuity of the Climate Data Records — An Enormously Important Task

Recognizing that changes in sensor technology will occur from the onset of the modernization program and continue through the life of the program, data continuity studies shall be conducted. Based on recommendations from NCDC that vests authority in the State Climate Offices (SCOs) and the Regional Climate Centers (RCCs), the data continuity studies will focus on (but are not limited to) COOP sites in the Historical Climate Network (HCN) which are selected for automation. The NWS will conduct these studies following established practices of the Government that are described in NWS Directive (NDS) 10-21 and its associated instructions.

It is important to note that data continuity studies associated with this modernization plan will be required only at a subset of the Category 2 sites — that is, only at locations where automated sensors are chosen to replace legacy or traditional sensors. Data continuity studies are not possible at Category 1 sites (new locations) or Category 3 sites (non-NWS locations) and are not required at Category 4 sites (traditional sites not automated).

Even so, a rock-solid plan must be developed to protect the continuity of climate records by addressing the 'continuity of location' (or stationarity) and the 'continuity of observing practice'. Replacing all of the *best* COOP stations with automated stations interrupts the *best* climate records in North America.

The NCDC has existing COOP/HCN inter-comparisons underway that were based on benchmark data accuracy standards established for the CRN program. It is natural to port these techniques of data accuracy, record extension, and the determination of normals to the proposed COOP modernization. By combining the work of NCDC with that of the NWS on data inter-comparisons and data continuity, great science credibility will be added to the newly modernized COOP network.

The continuity of the climate record also is vital to understand the fundamental processes that feed back into improved short-term and long-term predictive models. Because the need for a continuous and robust climate record serves the interests of a broad community within NOAA and its partner institutions, the preservation of key climate records should be handled through collaborative efforts across that community.

It is recommended that each area WFO facilitate an ad hoc committee to select the "best" 20% of active COOP stations in its domain. From this selection, a subset will be identified for continued operation by traditional methods. This subset will represent <10% of the existing COOP network. These sites will be selected according to the following criteria: (1) superior exposure for climate observations; (2) length of existing climate record; (3) prospects for continued service by volunteer observers; (4) appropriate spatial distribution; and (5) other local needs.

This continuity committee should have a nucleus of local representation from the WFOs, SCOs, RCCs and interested academic professionals in the weather and climate sciences. Progress on this recommendation will rest in the hands of the Regional Site Selection Teams (Section 4.7).

# 3 — Program Acquisition and Scheduling

## 3.1 Acquisition Goals During the COOP Modernization

The acquisition objectives of the program to modernize the COOP network and build the National Cooperative Mesonet are to develop, acquire, and field the *premier* environmental weather, water, and climate-monitoring network of the United States. This network will provide for long-term, stable surface observations that are representative of conditions across the United States to enhance the well-being of our nation's economy and the overall safety of citizens in the United States.

Site selection is particularly important, as the modernized COOP sites must remain largely stable for many years and be adaptable for the evolving requirements of multiple government agencies. Because the NCDC has considerable experience with site selection procedures that were developed as part of the Climate Reference Network, their expertise will be especially valuable when the Regional Site Selection Teams convene (Section 4.7).

The actual system technology will evolve over the years but the locations should remain largely constant and continue to be representative of the mesoscale environment to which they are exposed. The modernized COOP network and the National Cooperative Mesonet will be designed to be highly reliable, expandable, maintainable, and forward compatible. The network also is intended to serve as a model environmental monitoring network for the United States and the international community.

All phases of the development, acquisition, and implementation are being *designed for completion within five (5) years after the COOP modernization begins to reduce the risk that the continuity of the modernization will be compromised and to reduce the costs associated with operating and maintaining dual COOP networks*. Alternative strategies to complete the modernization are described in Appendix G. A potential implementation strategy that places heavy emphasis on partnering and cost sharing with key agencies in the 50 states is outlined briefly in Appendix H.

Specific acquisition objectives are to:

- Document system requirements and modes of operation
- Develop cost-effective solutions
- Develop risk mitigation approaches and to manage these activities accordingly
- Thoroughly test, evaluate, and document required technical elements
- Acquire sites with the characteristics desired in a stable, long-term and representative exposure
- Once modernization begins, install ~1600 sites per year using multiple installation teams
- Establish effective maintenance support and configuration management capabilities

- Meet established cost, schedule, and performance requirements
- Purchase sensors and related electronic equipment and contract a systems' integrator and network installer
- The systems' integrator also will be expected to provide contract maintenance, repair, and recalibrations and to meet established observing and maintenance standards

## *3.2 Program Schedule*

The current program schedule and its major phases are illustrated in Figure 4.

The COOP Steering Committee (Section 5.2) will review the proposed program decisions before the Modernization and Acquisition Program Manager assesses the final state of 'readiness for operations'. The CSC will review the test and evaluation findings and methodology, identified risks, proposed corrective actions, and provide recommendations to the Modernization and Acquisition Program Manager before the key decisions are made.

## *3.3 Demonstration Phase — The New England High-Resolution Temperature Initiative*

During this phase of the program, up to 200 modernized, baseline COOP sites will be installed in the New England area to support the New England High-Resolution Temperature Forecast Program. Funding for this phase was provided by a Congressional Earmark but is not part of the COOP Modernization Program budget. Key objectives during this phase include valuable risk reduction and prototyping activities that will support subsequent phases in the life cycle of the COOP Modernization Program. Lessons learned about programmatic risks and technical issues will be documented and applied to all program planning activities and system development efforts.

## *3.4 Requirements/Solicitation Phase*

This phase encompasses the definition of the program and includes requirements and actions necessary for the award of a COOP Modernization contract.

Requirements definition will lead to a functional requirements document that, along with the Program Statement of Objectives (Sections 3.7 – 3.9), will form the basis for the release of a "Request for Information" from Industry. This information will be used as input to finalize the requirements and Statement of Objectives, leading to the release of the "Request for Proposal". The Program Office will investigate innovative acquisition strategies for the implementation of the program (e.g., as discussed in Appendix H).

## *3.5 Development Phase*

This phase of the acquisition process will encompass development and evaluation of the system to be deployed at COOP observation sites. The individual steps to be accomplished during this phase are:

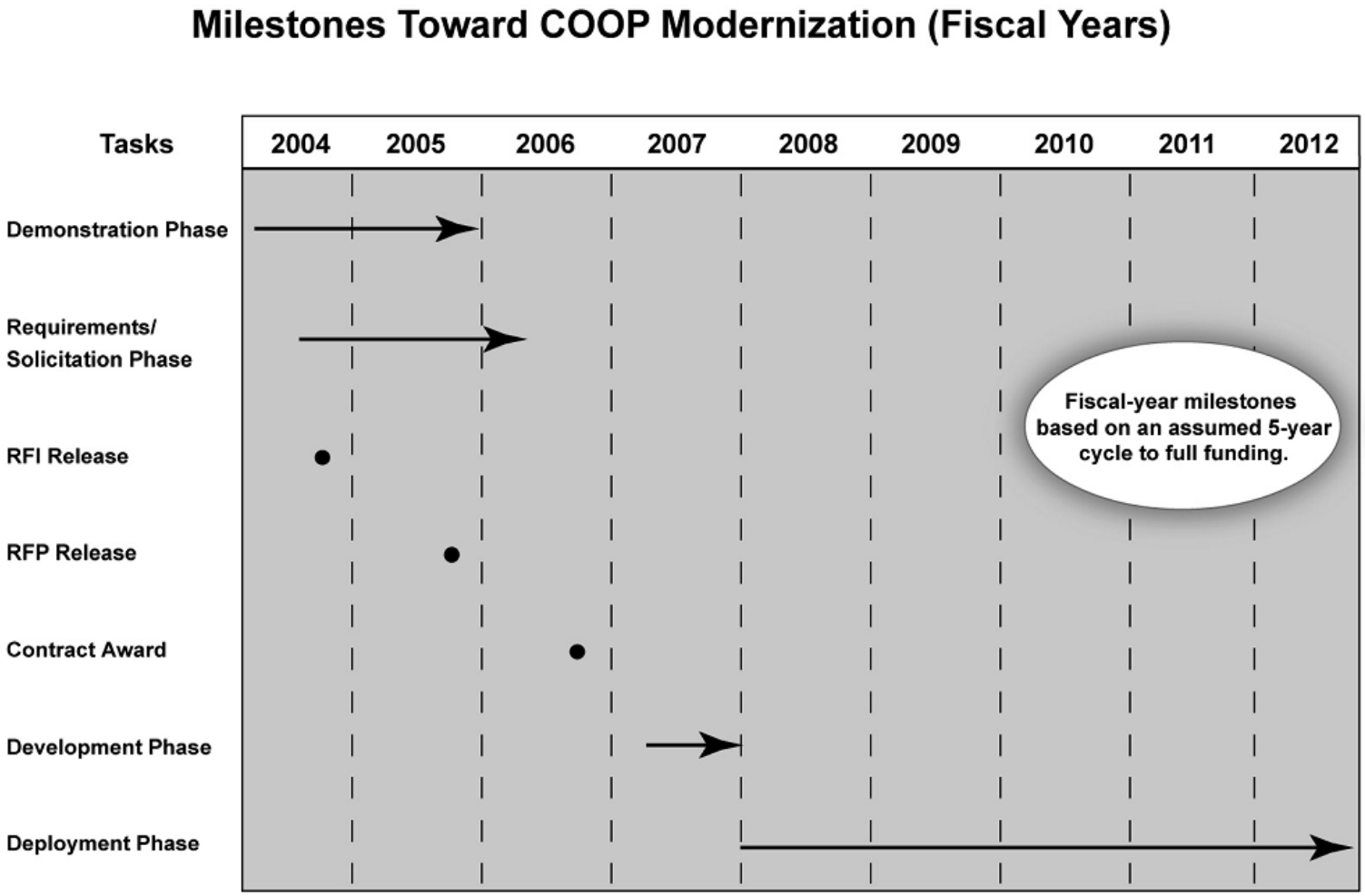


*Figure 4. Program phases by Fiscal Year of COOP modernization*

1. Requirements Analysis and Detailed Design
2. Development of the Baseline System
3. Integration and Testing
4. Operational Demonstration and Evaluation
5. Logistics, Maintenance, Recalibration, Training, and Deployment Planning

## *3.6 Deployment Phase*

This phase concludes the acquisition process and results in full-scale deployment of the modernized system. The Deployment Phase consists of these major tasks:

1. Production
2. Sensor Calibrations, Installation and Training
3. Field Integration

## *3.7 Contract Objectives*

- The Government will identify all locations where automated COOP stations will be installed. At this writing, it is not known precisely how many automated COOP stations will fall into observing Categories 1-3. *Only after the Regional Site Selection Teams have accomplished their tasks will the actual percentages be known.* In addition, some non-NWS stations (owned and operated by other organizations) may require partial equipment upgrades to meet COOP standards to become Category-3 sites.
- Government Furnished Equipment (GFE) will be provided as specified in the Functional Requirements Document. All development and testing must be accomplished at the contractor's facilities or at remote field locations that are jointly selected.
- After installation of automated COOP equipment, the contractor will be responsible for all maintenance, recalibration, and logistical activities that are part of the contract.
- All Design Reviews must be built into the schedule for acquisition and deployment.
- Deviations from the technical requirements must be approved by the Government.

## *3.8 Engineering Objectives*

- Site preparation, installation, maintenance, sensor recalibrations, logistics, and user training shall be accomplished by the contractor.
- Prototyping and beta testing will be performed with government representatives to ensure that technical requirements are implemented.

- The modernized network shall be built around an open, COTS-based design for all system and subsystem components. Industry accepted interfaces must interoperate and exchange data with current and future NWS systems (i.e., the loggers and sensors must be forward compatible).

- The affordability and life-cycle costs throughout the design, development, and deployment must be considered to sustain the system. This means that some standardization in the meteorologic sensor industry must occur for the modernized COOP to thrive for decades to come.

- The "best valued", most cost-effective technology available must be provided when the system is delivered. Advances in hardware technology must be easily incorporated throughout the delivery schedule.

- All requirements in the Functional Requirements Document must be followed.

- Data from the modernized COOP must be in a format that can be ingested into a central server to be identified. The communications equipment used at automated COOP sites shall transmit data using industry standard protocols.

- The network design must be modular and allow for additional sensors. The NWS will work with its industry partners to identify reasonable hardware and software requirements to meet the program needs. Indeed, the modernization of the COOP network is a unique opportunity to jointly identify and establish interface protocols, communication standards, algorithms and sensor compatibilities with industry and other agencies. These details will be provided in the FRD and in the plans for a "Concept of Operations."

- Additional details on the intent for hardware procurement, intended maintenance concept and future procurement of components will be addressed after the 'top level' PDP has been approved. A plan for the "Concept of Operations" will be written before the RFP is released (See Table 2 in Section 4.10 and Figure 4 for future activities.).

## *3.9 Program Objectives for the Contractor*

- Select subcontractor(s) with demonstrated, successful past performance with site preparation, installation, maintenance, sensor recalibrations, logistics, and user training for meteorological observation systems.

- Establish a sound risk-management system. Apply risk management to all phases of the program.

- Create a program management system that allows complete visibility into the program costs, schedules, and performance.

- Establish an Earned Value Management System in compliance with EIA-748 and report earned value to the Government throughout the program life-cycle.

- Establish and maintain a standards-based configuration management system.

- Provide monthly reports to Government representatives on the status of the modernization program.
- Provide a detailed breakdown of the work structure and cost analysis.

# 4 — Acquisition Management of the COOP Modernization

## 4.1 Management Approach

A COOP Program Office will be established to lead the acquisition and implementation of the modernized COOP. The Program Office will *assume the end-to-end responsibility for the COOP Program*, from acquisition of the modernized technology to its long-term maintenance to overseeing the integration of thousands of surface observations into the National Cooperative Mesonet and into routine NWS operations. A COOP Modernization and Acquisition Program Manager already is providing the initial management of the acquisition and implementation and will become part of an extended program team.

The senior leadership of the NWS will develop policy-level direction and define the functional and network requirements for COOP modernization. The NWS also will provide for a new Central Operations and Monitoring Center (COMC; described in Section 5.4) which will function to oversee a distributed ingest system with mirrored data archives, and quality assure and disseminate data acquired through the Central Facility in support of the National Cooperative Mesonet. The COMC also will monitor the performance of the automated COOP network and will provide performance metrics on a regular basis to the operational Program Manager (Section 5.3).

## 4.2 External Advisory Board (EAB)

A policy-level External Advisory Board will be established to provide advice on the COOP modernization. Once the modernization is complete, the primary duties of the EAB will be to provide top-level reviews of how the modernized COOP network is performing and how the Central Facility supports the integration of surface observations within the National Cooperative Mesonet. This Board is described in Section 5.1.

## 4.3 COOP Modernization and Acquisition Program Manager

A Modernization and Acquisition Program Manager will oversee acquisition and transition activities of the COOP modernization. This individual will provide the primary management of the acquisition and implementation activities associated with building the National Cooperative Mesonet. The Modernization and Acquisition Program Manager is responsible for:

- Planning, organizing, and coordinating overall activities of the COOP modernization
- Budgeting and authorizing work for the COOP acquisition and modernization
- Acquiring and implementing systems in coordination with the operational Program Manager of the modernized COOP
- Organizing and managing technical teams (e.g., for requirements, testing, etc.)

- Developing key plans and documenting work accomplished (e.g., Functional Requirements, Test Plans, evaluation and analyses, Management Plans, performance measures, etc.)
- Developing cost projections and budget initiatives
- Working with the NWS Office of Climate, Weather and Water Services (OCWWS) to define future requirements and to develop the plan that details a concept of operations

The Modernization and Acquisition Program Manager will work with the COOP Steering Committee (Section 5.2) to plan and organize activities (e.g., demonstration evaluations, development of site selection strategies, etc.). The NWS Offices of Climate, Weather and Water Services and Science and Technology (OS&T) will work to develop processes that are needed to evaluate network performance, monitor maintenance, oversee site acquisition, and other COOP activities.

In coordination with the operational Program Manager (Section 5.3), the Modernization and Acquisition Program Manager will review progress on a regular basis and determine readiness at the major program checkpoints and Key Decision Points. While budget planning will be led by the Modernization and Acquisition Program Manager with assistance from the operational Program Manager, the final budget plan and all budget initiatives along with final implementation decisions and relevant policies are to be approved by NOAA's Assistant Administrator for Weather Services.

## *4.4 Configuration Control Board for the Modernized COOP (CCCB)*

This group is appointed and chartered by the CSC (Section 5.2) to make decisions for change and configuration management of automated sites (site moves, software upgrades, new quality assurance procedures, etc.) in the modernized COOP. The CCCB will have approval authority for sites recommended to become part of the modernized COOP; they will communicate these decisions to the COOP Modernization and Acquisition Program Manager and to the Program Manager for the modernized COOP. This Board also will provide written reports as appropriate and will defer decisions involving large expenditures or proposed changes in policy to the CSC.

## *4.5 Change Management*

A change management system will be implemented with the modernization of the COOP. The members of the CCCB will evaluate requests for change and provide guidance to the Operational Program Manager and to the Modernization and Acquisition Program Manager. Requests for change may come from any of NOAA's public or private sector partners but these requests must be sponsored through one of the management levels that underpin the management systems of the modernized COOP network. After site commissioning, requests for change will be submitted through the operational Program Manager. The change management system will ensure resolution of issues.

## 4.6 Configuration Management

Both the NWS and the contractor for COOP modernization will have configuration management responsibilities for automated COOP sites. Interactive databases will be developed for tracking the configuration of all COOP sites and for other sites that become part of the National Cooperative Mesonet. The operational metadata system may evolve from the current Cooperative Station System Accountability (CSSA).

## 4.7 Regional Site Selection Teams for the Modernized COOP (RSSTs)

*Among the most important of decisions* that will be made during the modernization of the Cooperative Observer Network *will be the complicated and lengthy task of site selections.* While the regional teams must recommend *only one* automated COOP site for each grid square (20 miles x 20 miles), the standards for selecting COOP sites to be modernized are detailed in Appendices E-F. The design team for modernizing the COOP network believes the standards for site and sensor operations are *design criteria that must not be compromised*. The goal is to have these standards adopted as broadly as possible.

To assist with this *arduous selection process*, Regional Site Selection Teams will be formed and organized around the domain of each NWS region. These multiple groups will participate in the process to recommend sites and site configurations to the Configuration Control Board (Section 4.4) to become part of the national modernization. The groups are chartered by the CCCB with a *core membership* drawn from NWS Forecast Offices (WFOs), River Forecast Centers (RFCs), NWS Regional COOP Program Managers (RCPMs), Regional Climate Centers (RCCs), State Climate Offices (SCOs), the National Climatic Data Center, the United States Department of Agriculture (USDA), the state Departments of Transportation (DOTs), and other partners who choose to be involved in the modernization process. Other public and private sector partners will be invited into the core membership or be invited to participate on an ad-hoc basis as various private and public mesonetworks are considered for integration into the modernized COOP network and into the National Cooperative Mesonet. Because the NCDC has considerable experience with site selection procedures that were developed as part of the Climate Reference Network, their expertise will be especially valuable when the Regional Site Selection Teams convene.

The regional teams will receive guidance and training support from the CCCB. The teams will operate under team charters and meet throughout the modernization effort. Appendices E-F provide important guidance as this task gets underway. The Chair (and co-Chair) of all Regional Site Selection Teams will be selected as the teams are convened.

Because site selection and site maintenance are so significant for the long-term health of the modernized COOP network, Government personnel or their representatives will be encouraged to provide independent inspections to verify that siting and observing standards are met.

## 4.8 Site Selection and Site Configuration

The spatial density of sites in the modernized COOP *requires a national grid that will be populated with one automated COOP site in each square mesh* that measures 20 nautical miles by 20 nautical miles. While thousands of additional automated sites may be integrated into the

National Cooperative Mesonet, *this Plan only addresses the first site to be selected for each grid square in the modernized COOP*. However, this spacing may not be needed or feasible in some parts of the nation due to terrain or inaccessibility. Other locations, such has the major urban corridors of our Nation, may warrant additional considerations by the Site Selection teams.

1. The Regional Site Selection Teams will evaluate Category-3 sites that meet the standards of the modernized COOP network, whose equipment owners wish to participate in the COOP network and whose platforms fulfill a spatial requirement of the modernized COOP. These teams will make formal recommendations to the CCCB on Category-3 sites that should be included in the modernized COOP network, and thereby, fill a void in the national grid. With this information, the Modernization and Acquisition Program Manager will know how many Category-1 and Category-2 sites remain to be automated.

   Thus, the regional teams must identify the grid boxes where current COOP sites will not be recommended for automation. Depending on recommendations from NCDC, automated sites in the Climate Reference Network (CRN; managed and maintained through NCDC) may become Category-3 sites in the modernized COOP network.

2. The prioritized list for implementing sites during the modernization of the COOP network is listed below. However, this list may be modified by the Regional Teams *to balance installation priorities with personnel available after modernization resources become known*.

   (1) Hourly Precipitation Data (HPD) network sites (about 2500 nationwide) within the Historical Climate Network (HCN) — The HPD network is a vital sub-network within the traditional COOP network whose hardware is in danger of failure. These sites must be modernized during the first years of modernization and will become Category-2 sites, provided they individually meet the site, sensor, and observing standards established for the modernized COOP network (i.e., WMO and NWS standards, listed in Appendix E and in the FRD).

   (2) HPD sites not within the HCN — At least 1500 HPD sites are not within the Historical Climate Network. A high priority will be placed on modernizing the remaining HPD sites.

   (3) New sites in the modernized COOP network — New sites will be installed to fill the national grid in data sparse areas. These new sites will be Category-1 sites (or Category-3 sites when non-NWS sites are selected). It is possible that a human observer will not be an active participant at some of the Category-1 or Category-3 sites. Yet, this Plan acknowledges the fact that the human observer is, and will remain, the most consistent, yet adaptable observing platform in the world.

   (4) Remaining HCN sites — Assuming that siting and observing standards are met, the remaining HCN sites that are located in grid squares for which automated COOP stations have not otherwise been allocated will become Category-2 sites. About 1220 HCN sites are in operation, but most HCN sites will have been modernized concurrent with the modernization of HPD sites.

(5) Existing COOP sites that are recommended to become automated and integrated into the National Cooperative Mesonet. These newly automated sites are considered Category-2 sites.

(6) Selections to meet specialized network priorities — such as drought monitoring, water management, transportation weather, and the like — may occur concurrent with other priorities, but the special needs should not delay the highest priority installations to address deteriorating COOP sites. For example, a high priority exists to modernize HPD sites and to provide real-time drought monitoring. In other words, the initial HPD sites to be modernized should be locations that also are valid for drought monitoring.

3. Two site configurations are designed for automated COOP sites:

- **Baseline Sites** — *All automated COOP sites will provide baseline measurements of temperature and precipitation.* Data transmission will occur in real-time at hourly intervals with a goal of transmitting 5-minute observations at 15-minute intervals. Many of the newly automated COOP sites will have human observers who will have the ability for real-time transmission of manually entered data. These manual observations include 24-hour snowfall, current snow depth, liquid water equivalent of frozen precipitation, and other elements specified in the observer's handbooks or instructions. See Section 2.3 and Table 1 for additional details. Due to budget limitations, *the modernized COOP sites will not have backup precipitation gauges should the automated gauge fail nor will they have new automated stream gage sensors.*

- **Enhanced Sites** — Additional sensors may be added at the baseline sites in the COOP network to meet other needs of NOAA and its partners. Enhanced sites will be supported by agency requirements and will comply with the siting and observing standards for the modernized COOP. See Section 2.3 and Table 1 for additional details.

4. The Regional Site Selection Teams will provide site recommendations by categories, siting and installation priorities along with each site configuration to the CCCB. The Regional Teams will solicit participation from NOAA's public and private sector partners on an ad hoc basis to determine the location of sites where enhanced measurements will be made. *All COOP sites with below-standard siting and exposure must be relocated if they are to be automated. Otherwise, traditional COOP sites will be considered as Category-4 sites. Even so, a traditional COOP site could meet all siting standards and still become a Category-4 site due to the requirement to place only one automated site in each 20-mile grid square.*

5. The CCCB will have approval authority for all Category-1, Category-2, and Category-3 sites and will base their decisions on recommendations from the Regional Teams.

(1) The CCCB will provide the final siting decisions to the Modernization and Acquisition Program Manager for the COOP sites to be automated.

(2) The Modernization and Acquisition Program Manager, through the Contract Officer's Technical Representative, is *the only person* who can task the modernization contractor. The Modernization and Acquisition Program Manager will provide the contractor with site locations, priorities, and configurations on a recurring basis.

(3) Potential Category-3 sites not needed to fulfill a spatial requirement of the modernized COOP or not meeting site, observing, and maintenance standards will be considered as complementary data to the NWS mission. Regardless, *these network owners are strongly encouraged to have their observing systems become part of the National Cooperative Mesonet* defined in Figure 1 and Sections 2.3 and 2.5. A means of accomplishing this objective is illustrated in Appendix H.

6. The RSSTs will provide recommendations on remaining COOP, HCN, and/or HPD sites that should be maintained as Category-4 sites. Sites with short duration or poor quality records may be discontinued, unless local climate factors require such sites be maintained or relocated within established climate monitoring principles (Appendix E).

## *4.9 Maintenance and Training for the Modernized COOP*

Maintenance for Category-1 and Category-2 sites will be performed by the modernization contractor. Restoration times and priorities for restoration will be established by the Government and overseen by the COOP Operations and Maintenance Center (Section 5.4). Maintenance actions for Category-3 sites will be determined by the platform owners but reviewed on a case-by-case basis at the COMC to confirm that siting and observing standards have not been compromised. Maintenance of Category-4 sites will continue to be the responsibility of the NWS (hence, the WFOs). The modernization contractor is responsible for ensuring the continued accuracy of all sensors through orderly calibrations, scheduled recalibrations, and site visits.

The NWS will use the high-resolution data from automated COOP sites in all appropriate training courses. The WFO staffs will continue to provide training for human observers at the traditional COOP sites. The modernization contractor must provide training materials and documentation to the NWS. Training from the modernization contractor will not be required for Category-3 sites because this task is the responsibility of the platform owner.

## *4.10 Document Tree for the COOP Modernization*

| Initial Plans | Demonstration Plans | Evaluation Plans | Implementation Plans | Maintenance Plans |
|---|---|---|---|---|
| **Concept of Operations**<br><br>**Functional Requirements Document**<br><br>**Network Requirements Document** | **Demonstration Evaluation Plan**<br><br>*Systems Engineering Management Plan* | *Test and Evaluation Master Plan* | **Site Acquisition Plan**<br><br>*Installation and Acceptance Plan* | *Maintenance and Operations Plan* |

***Table 2. Document Tree Supporting the COOP Modernization. Documents in italics are contractor-developed but NOAA approved; documents in bold are NOAA-developed.***

# 5 — Operational Management of the Modernized COOP

## 5.1 External Advisory Board

The members of this Board will provide scientific, managerial, and programmatic advice through an annual assessment to the NOAA Administrator, to the Director of the NWS and to Steering Committee of the modernized COOP network and the National Cooperative Mesonet. The members (~7) will be non-federal experts appointed by the Under Secretary of Commerce for Oceans and Atmosphere to serve overlapping 3-year terms. The members shall represent academia, the private sector, and state or local government. They will elect their own Chair and will meet annually to review activities, problems, and opportunities that contribute to mission-related responsibilities involving the modernized COOP network and the National Cooperative Mesonet.

## 5.2 COOP Steering Committee

This group, chartered by NOAA and its partners (e.g., Federal Highway Administration, U.S. Department of Agriculture, USGS, COE, etc.) will set and revise the general policy and practices of the traditional COOP, the modernized COOP, and the National Cooperative Mesonet. They will provide policy direction and act on recommendations from the EAB. The Steering Committee membership shall be drawn from the senior NWS management (or their representatives) in the OCWWS, OS&T, Office of Operational Systems (OOS), Office of Hydrological Development (OHD), Office of the Chief Financial Officer (OCFO), Office of the Chief Information Officer (OCIO), the NCDC, and representatives from other NOAA partners who contribute to the operation and maintenance of the National Cooperative Mesonet. One member shall be drawn from the staff at a Regional Headquarters Office or from a WFO/RFC. This committee shall have *no more than 11 members*.

The Steering Committee will hold the Program Director and the Program Manager accountable for a timely resolution of all management, administrative, and technical issues that arise on a day-to-day basis.

An ‘internal’ Advisory Board may be convened at the pleasure of the COOP Steering Committee to handle specific operational problems that may arise. This ‘internal’ Board will be composed of operational personnel from the WFOs and RFCs.

## 5.3 Program Manager for the Modernized COOP

The operational Program Manager shall be responsible for day-to-day management of the automated COOP network and its role in the National Cooperative Mesonet. These responsibilities begin with the commissioning of the first modernized site. This position will reside in the proposed COOP Program Office. This individual will be accountable for implementing recommendations from the Steering Committee and will serve as a permanent member of the CCCB (Section 4.4). Most importantly, the Program Manager must work closely with the COOP Operations and Monitoring Center (Section 5.4) to inform the maintenance

contractor and other associated network owners of system compliance with the operational specifications and other operational standards.

## *5.4 COOP Operations and Monitoring Center*

The COMC represents a vital and independent unit responsible for data ingest, and quality assurance monitoring of data from the automated COOP network and from networks that are operated by other NWS partners who participate in the National Cooperative Mesonet. Even though the COMC will use a distributed ingest system with mirrored data servers, the Center also will be responsible for ensuring the timely dissemination of data (i.e., less than ~12 minutes after the initial data transmission) from the automated COOP network and the National Cooperative Mesonet to the broad user community as illustrated in Figures 1 and 3. The COMC will have quality assurance meteorologists and systems analysts who will inform the operational Program Manager of network performance on a regular basis. During the acquisition period of the COOP modernization, the COMC will have a responsibility to inform the Modernization and Acquisition Program Manager of network performance. The responsibility for maintaining up-to-date metadata files and for initiating trouble tickets will reside within the COMC.

A Program Director will be responsible to establish and coordinate consistent equipment, telecommunications, data collection points, and data formats across all networks that compose the National Cooperative Mesonet.

As the modernization nears its end, the COMC will continue with its responsibility to track and oversee the resolution of maintenance decisions sent to the COOP contractor. The COMC will be responsive to trouble tickets and for directing the resolution of inquiries from all data customers of the National Cooperative Mesonet (i.e., WFOs, RFCs, partner agencies, private companies, SCOs, RCCs, and other stakeholders). On a regular basis (e.g., weekly, monthly, or quarterly), *the COMC will provide performance metrics about the modernized COOP to the operational Program Manager*.

All data from the National Cooperative Mesonet will have been quality assured in real time using proven techniques that improve the quality of an integrated dataset without creating unacceptable delays (i.e., >15 minutes after the initial data transmission). The data and its QA flags will be made available to a distributed network of users. WFOs, RFCs, and NCDC are envisioned to receive their primary feed of COOP and National Cooperative Mesonet data via the Internet and various NWS telecommunications systems (Figure 3). Important details on the required metadata and on the procedures for data quality assurance are found in Appendix D. The concept of COOP operations in the context of a National Cooperative Mesonet is illustrated in Figures 1 and 3. Administration of the automated COOP network is illustrated in Figure 5. If proven to be economically viable (i.e., benefits outweigh costs), the Central Facility will be designed to have a backup capability for situations when major system failures occur. At a minimum, the COMC will support a distributed network of mirrored servers.

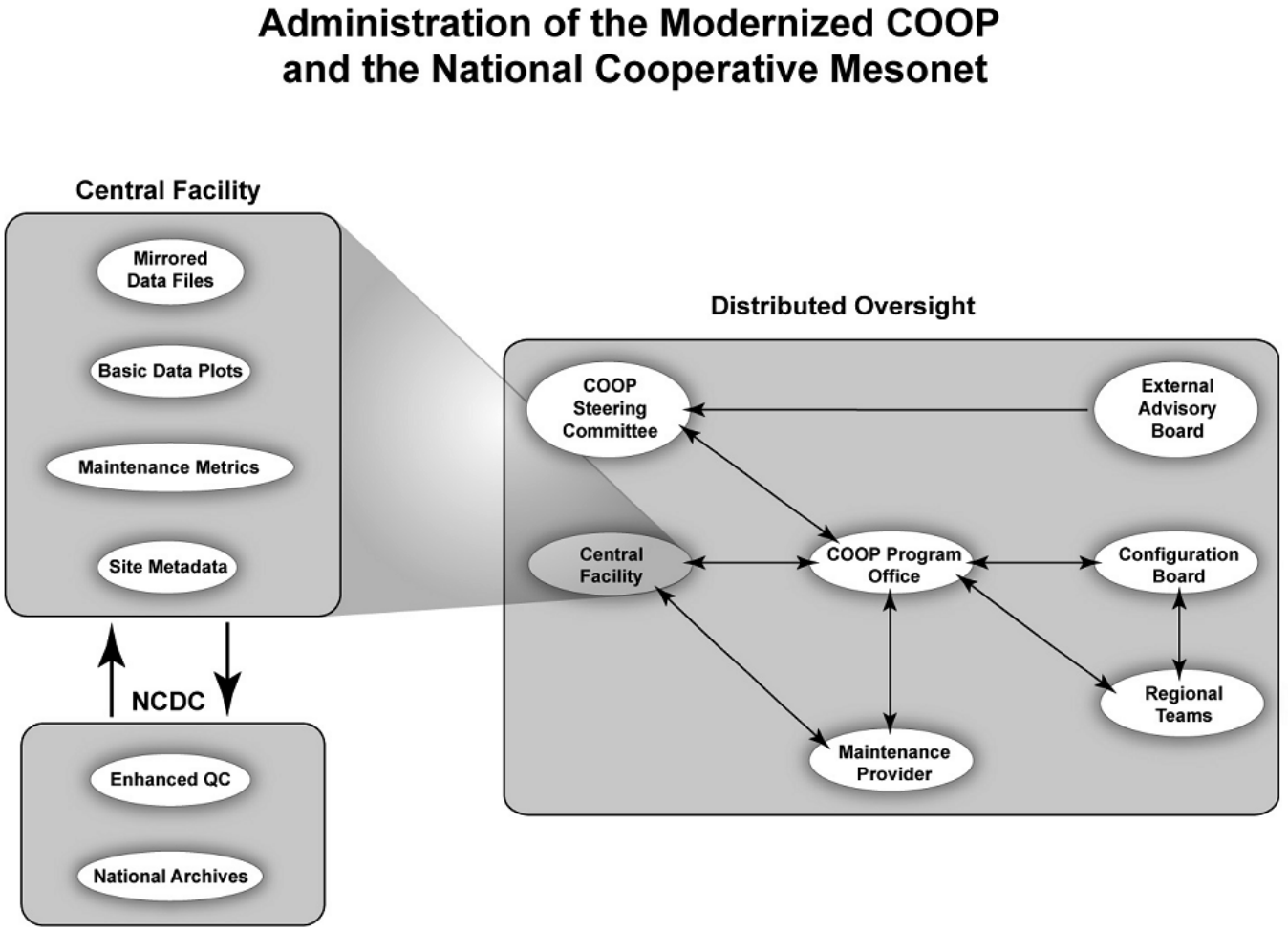


*Figure 5. Overview of program and data administration of the modernized COOP*

# *Appendix A — Dividends From the COOP Modernization*

### Utility Industry

- *"One degree of improvement in temperature [forecasts] is worth one billion dollars."* (Roger Krenenburg, Director of Business Development at Edison Electric Institute; presentation at a COOP Partners' Forum in September 2002)

- "The Tennessee Valley Authority [TVA] generates 4.8% of the nation's electricity. Temperature forecasts over its 80,000 square miles have been wrong by an average of 2.35 degrees these last 2 years, fairly typical of forecasts nationwide. Improving that to within 1.35 degrees would save TVA as much as $100,000 a day, perhaps more." (*USA Today*; June 19, 2001).

- The value of understanding the interrelationships between weather variables and electric load can save a small utility at least $500,000 annually through improved temperature forecasts (Tribble 2003).

- Weather forecasts introduce 1% of additional error in load forecasts (Khotanzad et al. 1998) [such that] a conservative estimate is that a 1% reduction in [load] forecasting error for a 10,000 MW utility can save up to $1.6 million annually (Hobbs et al. 1999).

- [There is] "a municipality in the southwestern United States that wants to protect itself in the case of too little rainfall. Under such circumstances, they must buy extra power from the [power] grid. COOP stations are very important, but there are gaps in the data. Consequently, these data are not good enough for us to price a product." (Lynda Clemmons, President of Weather Risk Management Association; presentation at a COOP Partners' Forum in September 2002)

- "By effectively using accurate rainfall forecasts in our hydro operations, Duke Power can save several million dollars annually in preventing 'wasted' water — water moved past the hydro station but not used for hydroelectric generation." (Bill Coley, President of Duke Power; comments at The First AMS Presidential Policy Forum in January 2001)

- A one-degree error in the forecasted high temperature can lead to more than a gigawatt (one billion watts) impact on energy generation over a six-state region in the upper-Midwest and a half-gigawatt impact over Florida alone (2002; personal communication between Williams Energy Marketing and Trading Company and Professor Kelvin Droegemeier in 2002).

### Emergency Management

- [The Oklahoma] "Mesonet is without a doubt among the most important data sets we use at the National Weather Service Forecast Office [in Norman, OK]. In addition to routine forecast and warning operations, the Mesonet is invaluable for handling various disaster support situations including wildfires, chemical spills, and catastrophes like the Oklahoma City Murrah Building bombing." (David Andra, WFO Norman; quote from NRC 2003)

## Agriculture

- "Monthly precipitation data was *the key to determining the outcome of a $2 billion lawsuit* brought by several southwest Indian tribes against the U.S. Government concerning the overgrazing of reservation rangeland." (NRC 1998)

- *"The dispensation of $500 million in federal drought insurance was decided by precipitation records from COOP stations during the 1988 drought in the Midwest.* In one case, $6 million was paid on the basis of records from one station." (NRC 1998)

- "One precipitation observation that was wrongly keyed during the summer of 1988 almost cost a farmer his drought insurance claim of $70,000. A rainfall of 0.07 inches was keyed as 0.17 inches, putting the seasonal total above the threshold for collecting on the policy. Only when the records were rechecked was the error noticed." (NRC 1998)

- "There are 600,000 irrigated acres across Oklahoma. It costs $4 to put one inch of irrigated water on each acre. If more scientific irrigation strategies were adopted based on reliable local data, it is likely that one acre-inch of irrigated water could be saved each year. As a result, the agriculture industry in Oklahoma would realize an annual savings of $2.4 million." (Professor Ron Elliott, Oklahoma State University)

- "The [OK] Mesonet has proven to be one of the most valuable production and marketing tools available to Oklahoma producers. For example, in April 1997, a late freeze had potentially affected over 6 million acres of Oklahoma wheat. Producers were faced with the economic decision of leaving the crop for grain production or salvaging it for hay. Mesonet data helped producers and agronomists to quickly and accurately assess the damage and make the most informed decisions possible." (Mark Hodges, Executive Director of the Oklahoma Wheat Commission)

- The USDA used COOP data to develop a plant hardiness map that is <u>printed on almost every packet</u> of seeds.

- "The USDA uses timely weather and crop information as part of its key indicators used by the world commodity markets." (Dr. Gerald A. Bange, Chair of USDA's World Agricultural Outlook Board)

## Water Management

- "An important part of the COOP network is the high-resolution precipitation data needed to evaluate flooding, stream-bed erosion, and surface runoff." (Dr. Tom Karl, Director of the National Climatic Data Center)

- "Observations from the COOP network are indispensable inputs to the *Drought Monitor*, a product that is widely used by policy makers, the media, and others." (Dr. Gerald A. Bange, Chair of USDA's World Agricultural Outlook Board)

- "Total storm rainfall amounts and associated short-duration intensities reported by COOP stations provided the basic information used by engineers and meteorological consultants to assist the courts in determining the reasons and legal responsibilities for the washout of a major bridge span in Puerto Rico that resulted in 27 deaths and a $65 million lawsuit." (NRC 1998)

## General Commerce

- The U.S. Bureau of Economic Analysis (2002) estimated in 1998 that more than a third of the nation's $10 trillion economy, as measured by the gross domestic product, is sensitive to weather and climate. Dutton (2002) confirmed these findings.

- The National Homebuilders Association used COOP data to change their standards for the foundation footing of new homes. The estimated annual savings is $200 million.

- "The COOP network is a gold mine of data that has been used in millions of decisions. In the United States, there is $13 billion in property damage and 80 deaths per year related to drought and flood. The modernized COOP will provide data that will help manage these extreme events." (Samuel W. Bodman, former Deputy Secretary of Commerce; presentation at a COOP Partners' Forum in September 2002)

- The U.S. has sustained 58 weather-related disasters over the past 24 years in which overall damages/costs reached or exceeded $1 billion. Forty-nine of these disasters occurred during the 1988-2003 period with total unadjusted damages/costs of nearly $220 billion. The total normalized losses for the 58 events are nearly $350 billion (Ross and Lott 2003). All states in the continental United States have been impacted by at least one billion dollar disaster.

## Transportation

- Based on 2001 statistics, more than 1.4 million crashes occurred under adverse weather, which resulted in over 615,000 injuries and nearly 7000 traffic fatalities (Pisano 2003).

- From a productivity standpoint, the freight community experiences an estimated $3.4 billion annually in weather-related delay in metropolitan areas. Weather affects the timeliness of roadway repair, the safety of maintenance personnel in work zones, and the general mobility of all vehicles when conditions become hazardous (Pisano 2003).

- Transportation agencies spend about $2 billion annually for snow and ice control and $5 billion for infrastructure repair that is attributable to weather (U.S. Department of Transportation 2001).

- Commercial airlines use very short-term (0-4 hour) forecasts to minimize cancellations and delays/diversions — the average cost of which is ~$40,000 per flight and $150,000 per flight, respectively (Pielke 1997).

# *Appendix B — Organizational Roles and Responsibilities*

The success of the program to modernize the COOP network and its role in building the National Cooperative Mesonet hinges upon program integration and partnering between NOAA organizations and their external partners. This section describes the roles and responsibilities of each line office.

The NWS will serve as the lead NOAA agency to modernize the COOP network and to build the National Cooperative Mesonet. The responsibilities of each organization are summarized below.

- *Office of Climate, Water, and Weather Services (OCWWS)* — This office is responsible for gathering and coordinating various agency and partner requirements and for communicating this information to the COOP Steering Committee. They are the primary office to interact with public and private sector partners of the NWS and with the volunteer observers. OCWWS may manage the modernized COOP. Regardless, OCWWS sets policy, develops procedures, and provides training and change management.

- *Office of Science and Technology (OS&T)* —This office houses the program to modernize the COOP network and leads the activities associated with the modernization. The Program Director leads the government team to create the program plan, formulate budget initiatives, develop and test hardware solutions, acquire equipment for national deployment, manage funds for the modernization program, and contribute to building the National Cooperative Mesonet.

- *Office of Operational Systems (OOS)* — This office is responsible for the configuration management of systems associated with the modernized COOP. They will support the operational equipment and systems furnished by the Government, and develop required notes on engineering modification. This office will provide support for any centralized servers, software, or Internet activities operated by the Government on a national level. This office may be responsible for helping prepare an implementation plan, for helping manage the implementation, and for overseeing maintenance of the automated COOP.

- *Office of Hydrologic Development (OHD)* — This office is responsible to provide its requirements (e.g., data format, data frequency) to the Central Facility where almost all of the real-time processing of data from the modernized COOP and the National Cooperative Mesonet will occur. The OHD also is responsible to provide the data requirements of evolving hydrologic models, including the Hydrometeorological Automated Data System (HADS).

- *Office of Chief Financial Officer (OCFO)* — This office oversees all budget initiatives on behalf of the COOP modernization, is an interface with Congressional staffers, and sets the standards by which funds are accounted for during the modernization process.

- *Office of Chief Information Officer (OCIO)* — This office is responsible for any transmission of modernized COOP data through the NWS Telecommunications Gateway and NOAAPORT. This office provides guidance and technical support for data security.

In addition, this office will receive data from other observing platforms and systems that contribute to the National Cooperative Mesonet.

- *NWS Regional Headquarters* — Even though the various Regional Headquarters may be organized differently, the Systems Operations Divisions, the Electronics Program Managers, and the Regional COOP Program Managers (or their equivalent in each Region) will coordinate issues of regional responsibility with the national offices, the COOP Steering Committee, and their respective WFOs and RFCs.

- *NWS River Forecast Centers (RFC)* — The 13 RFCs are responsible for river basin forecast and warning activities. Their involvement in site selection for the modernized COOP is required to ensure that hydrologic needs at the field level are met. The RFCs will have a responsibility for quality evaluations of data from automated COOP sites and for notifications to the Central Facility.

- *NWS Forecast Offices (WFO)* — The 122 WFOs are responsible for oversight of automated COOP sites and for local management and maintenance of traditional COOP sites in their respective areas. The WFOs will have a responsibility for quality evaluations of data from automated COOP sites and for notifications to the Central Facility.

The National Environmental Satellite, Data, and Information Service (NESDIS) will work with the NWS to ensure the success of the COOP modernization and the building of the National Cooperative Mesonet. The specific role of each organization is described in this section.

- *National Climatic Data Center (NCDC)* — The NCDC is responsible for the long-term stewardship of and access to archived COOP data. NCDC serves as the liaison between the NWS and the Regional Climate Centers. NCDC will lead the effort to foster standardization of quality assurance/quality control routines for the COOP data. At the discretion of NCDC, all data will be reprocessed with enhanced QA/QC routines as modernized COOP data enters the national archives. Note Figures 3, 5 and 6 and Appendix D.

- *Regional Climate Centers (RCC) and State Climate Offices (SCO)* — The participation of the six RCCs and the various State Climatologists (though the SCOs are not organizations of NESDIS) are vital to the success of the COOP modernization and to building the National Cooperative Mesonet. The RCCs and the SCOs have a role to establish data and instrument requirements, site selections, and communication and processing systems. RCCs and the SCOs coordinate activities with the NWS through NCDC and the Regional Site Selection Teams. They may function as distributive data collection and dissemination hubs. The President of the American Association of State Climatologists (AASC) is a liaison to the AASC membership for activities associated with modernizing the COOP network and building the National Cooperative Mesonet.

- *Office of Satellite Data Processing and Distribution (OSDPD)* — This office provides support for the Geostationary Satellite (GOES) data collection system (DCS). The NWS manager for GOES DCS is housed within OCWWS and is the liaison to the OSDPD.

- *Office of Systems Development (OSD)* — This office is responsible for defining the Climate Reference Network (CRN) sponsored by NCDC. OCWWS and OSD coordinate

mutually beneficial activities that support the modernization of the COOP network, align the CRN and modernized COOP to avoid duplication of activities, and build a National Cooperative Mesonet.

The Office of Federal Coordinator for Meteorology and Supporting Research (OFCM) serves as the facilitating office for gathering interagency requirements. The OFCM has a standing committee for Integrated Observing Systems, which have two Joint Action Groups (JAG) associated with the COOP network. They provide new requirements to the COOP Steering Committee.

- *COOP Network Modernization JAG* — This JAG is led by the OCCWS and was established to coordinate requirements for a modernized COOP. The COOP density review, performed at NCDC, was sponsored by this JAG and may be reconvened when required.

- *Hourly Precipitation Data JAG* — This JAG is led by the OCWWS and was established to coordinate requirements for upgrading the sub-network within the COOP that provides hourly precipitation data. Because automated COOP sites will produce accurate data that are reliably available from all sites, the need for this group should be revisited.

The Office of Oceanic and Atmospheric Research (OAR) and its Forecast Systems Laboratory (FSL) also are important partners during the modernization of the COOP network and the building of a National Cooperative Mesonet. Their expertise with a prototyped centralized data collection and dissemination system (along with its QA/QC component) will play an important advisory role in the establishment of the COOP Monitoring and Operations Center.

In addition, FSL has a vision to help establish a national network of NDGPS equipment, possibly using ~4000 automated COOP sites as candidate locations to host this equipment. Because the Federal Highway Administration (FHWA) has a Congressional mandate and a similar vision to deploy a network of NDGPS sensors, FHWA and FSL should work through the COOP Steering Committee and its CCCB to establish joint requirements.

# *Appendix C — Partnership Roles and Responsibilities*

## *C.1 — NOAA's Public Sector Partners and Potential Partners*

The success of the program to modernize the COOP network and to build the National Cooperative Mesonet requires active participation between NOAA and its public sector partners and potential partners for an integrated surface-observing network to result.

*U.S. Department of Agriculture (USDA)* — The USDA is responsible for providing their requirements for automated COOP sites. At sites selected by the USDA for a suite of enhanced sensors, the USDA will provide the necessary support. The data collection capabilities of the USDA, including their use of Meteo-burst ground equipment, will be integrated with the other telecommunications technology used in the National Cooperative Mesonet. Quality assurance of data from sensors supported by the USDA will be performed at the COMC. *The expertise of the USDA is especially needed to define and support the growing requirements for a national drought-monitoring network that should become an important component of the modernized COOP network and its COMC, and the building of the National Cooperative Mesonet.*

*U.S. Geological Survey (Department of Interior - USGS)* — The USGS is responsible for providing possible sites, sensors and other requirements for automated COOP sites. At sites selected by the USGS for a suite of enhanced sensors, the USGS will provide the necessary support. While the USGS has about 5,000 data collection platforms, only a small percentage of these sites likely will become automated COOP sites. However, data from all USGS platforms will be integrated into the NCM via their use of GOES DCS. Working in cooperation with USGS scientists and engineers, quality assurance of data from the USGS will be performed at the COMC in addition to that performed by the USGS.

*U.S. Army Corps of Engineers (Department of Defense - COE)* — The COE is responsible for providing possible sites, sensors and other requirements for automated COOP sites. At sites selected by the COE for a suite of enhanced sensors, the COE will provide the necessary support. While the COE has about 3,000 data collection platforms, only a small percentage of these sites likely will become automated COOP sites. However, data from all COE platforms will be integrated into the NCM via their use of GOES DCS. Working in cooperation with COE scientists and engineers, quality assurance of data from the COE will be performed at the COMC in addition to that performed by the COE.

*Federal Highway Administration (U. S. Department of Transportation - FHWA)* — The FHWA will serve as a liaison to the many state DOTs that maintain a network of automated Road Weather Information Systems (RWIS). At automated COOP sites selected by the state DOTs for a suite of enhanced sensors, the state DOTs will provide the necessary support. While the number of RWIS sites across the nation is growing, data from RWIS sites are *highly desired components of an integrated NCM* — but only as state DOTs permit. Quality assurance of data from RWIS sites will be performed at the COMC. Because the FHWA has been congressionally mandated to implement an array of NDGPS sensors, the FHWA is encouraged to seek out modernized COOP sites to serve as host sites for these unique sensors. The FHWA also is encouraged to make known to the COOP Steering Committee the siting and observing standards established for NDGPS and RWIS sites.

*Other Government COOP Partners and Potential Partners* — Many other Government agencies are partners (or could become partners) in the modernization of the COOP network and the building of the NCM. These agencies could provide land, sensors and/or reimbursable funds to support designated sites in the modernized COOP network and in the NCM. Their requirements will be provided through the OFCM. These agencies are:

- Bonneville Power Administration - Current Partner
- Bureau of Land Management - Current Partner
- Cold Regions Research and Engineering Lab. - Current Partner
- Department of Homeland Security - Potential Partner
- Environmental Protection Agency - Potential Partner
- Federal Aviation Administration - Current Partner
- Fish and Wildlife Service - Current Partner
- National Park Service - Current Partner
- Natural Resources Conservation Service - Current Partner
- NOAA's National Ocean Service - Potential Partner
- NOAA's Climate Program Office - Potential Partner
- U.S. Bureau of Reclamation - Current Partner
- U.S. Coast Guard - Current Partner
- U.S. Forest Service - Current Partner

*Western Governors' Association (WGA)* — This Association of Governors from the western states are developing plans for a national drought monitoring network as part of a national integrated drought information and decision support system. They are strongly encouraged to use and support the modernized COOP network as host sites for sensors that they and the USDA deem appropriate for drought monitoring. Quality assurance of data from drought monitoring sensors will be performed at the COMC. The Western Governors' Association will be responsible for informing the Governors from all states about the opportunity to establish a national drought monitoring capability as the COOP network is modernized and a National Cooperative Mesonet is built.

*State and Local Government Agencies* — Many state and local agencies have data collection platforms with real-time communications and hydrometeorological sensors. Site selection teams will evaluate these data collection platforms as potential Category-3 sites in the modernized COOP. While leveraging the use of established statewide telecommunications systems is highly desirable (e.g., LETS), data from these platforms will be integrated into the NCM through new partnerships (Appendix H). Quality assurance of data from state and local sensors will be performed at the COMC. The platform owner must provide the required metadata. Quality-based support incentives are one means to attain climate-quality data when potential new Category-3 sites are provided by non-federal observing platforms. Section 2.5 provides more details.

## *C.2 — NOAA's Private Sector Partners and Potential Partners*

The success of the program to modernize the COOP network and build the National Cooperative Mesonet relies on partnering between NOAA and the private sector.

*Cooperative Observers* — These volunteer individuals, groups or institutions are long standing partners of the COOP. These volunteers freely provide their land and time to serve the nation and will continue to be an important component of the modernized COOP. It is essential to maintain respectful and appreciative relations with the volunteer observers who provide invaluable resources for siting and interaction during the modernization of the COOP network. Interaction with these volunteers will occur through the WFOs. COOP observers at automated sites will be involved in the siting of equipment on their property. Valued historical locations not selected for automation will continue to serve as traditional COOP sites and be maintained by WFO staffs.

*American Association of State Climatologists (AASC)* — Almost all states in the United States have state-supported climatologists responsible for monitoring and predicting the climate of their state and region. The AASC membership may provide data and site requirements through the AASC President and through the SCOs and RCCs.

*Private Data Providers* — Thousands of private data collection platforms across the United States are owned and operated by private companies and universities. While the quality of the platforms varies widely, many provide high quality data in a reliable manner. Site selection teams will evaluate candidate platforms for incorporation as a Category-3 site in the modernized COOP. Quality-based support incentives are one means to attain climate-quality data from non-federal platforms. *Memoranda-of-Agreement (MOAs) will be developed to define clearly the contributions or exchanges (Appendix I).* Quality assurance of data from these platforms will be performed at the COMC.

*Commercial Concerns* — The Nation's economic well-being is dependent on accurate hydrometeorological forecasts and warnings. The National Cooperative Mesonet will enhance the accuracy of all short-term forecasts and warnings, which in turn, will benefit all sectors of the economy (Appendix A). For example, the impact of improved temperature forecasts on the power generation industry could lead many commercial concerns to partner with the National Cooperative Mesonet. Businesses may partner with NOAA through resource contributions or an exchange of services (e.g., a business may provide sensors and/or the NWS may provide maintenance or communications). *Memoranda-of-Agreement (MOAs) will be developed to define clearly the contributions or exchanges (Appendix I).* Quality assurance of data from these platforms will be performed at the COMC.

*American Meteorological Society (AMS) and the National Weather Association (NWA)* — These professional organizations of hydrometeorologists and climatologists will be consulted as required.

*Private Weather Companies* — Unless prevented by specific MOAs, data from the modernized COOP and the National Cooperative Mesonet will be openly available in the public domain via the Central Facility and NWS telecommunications networks. The private weather organizations that benefit from NCM data are invited to contribute through partnering with NOAA.

# *Appendix D — Data Quality Assurance and Metadata*

## *D.1 — Quality Assurance and Quality Control*

Quality Assurance (QA) and Quality Control (QC) of automated COOP data, defined below as separate processes, are fundamental components of the COOP modernization, the foundation upon which the National Cooperative Mesonet is built. They are part of the end-to-end modernized system being designed to produce reliable data on a reliable basis.

A quality assurance system is composed of proactive humans and automated software techniques that are used in real-time to detect suspect data from a failing (or failed) sensor. The range tests at the remote logger level and the quality evaluation at the informed user level will supplement the QA system at the Central Facility. While automated QA routines will be the overriding tool used at the Central Facility, human intervention by personnel specially trained in data quality assurance is essential to override automated QA flags assigned to each datum. A critical component of rigorous QA is the accurate flagging of data from the true start time of a data/sensor problem until the time the issue was resolved. Another goal of the QA system is to provide maintenance metrics to the operational Program Manager to improve the week-to-week efficiency in managing and maintaining the modernized COOP. The real-time QA system at the COMC (Section 5.4) will be as rigorous as possible to produce automated notifications that indicate system and site outages or suspected erroneous data. An example of how a real-time QA system could operate is exemplified by the dynamic procedures described by Brock et al. (1995), Shafer et al. (2000), Fiebrich and Crawford (2001), Hubbard (2001a-b), and Miller and Barth (2003).

Quality Control is a very similar process, except it represents the post-processing, retrospective system used at NCDC. These rigorous QC techniques will be defined by NCDC prior to modernized COOP data entering the national archives.

*It is important to note that original data must never be altered.* However, QA flags assigned to each datum may be updated as often as deemed appropriate (e.g., late arriving data enters the network owner's archive, the data base at the Central Operational and Monitoring Facility, or the national archives at NCDC). NOAA's partners (governmental and private sector) are encouraged to provide enhanced QA of their network data and to share their QA/QC techniques through the CCCB (Section 4.4).

The levels of QC/QA illustrated in Figure 6 are more fully defined below:

- Site data loggers will be programmed to provide the most elementary of data quality assurance (i.e., only range tests) prior to the transmission of COOP data from each remote site (Figures 2 and 6).

- WFOs, RFCs, SCOs, RCCs, and other stakeholders who make aggressive use of COOP data should evaluate data quality through the subjective eyes of their skilled operational personnel and through local techniques designed to generate notifications for the Central Facility (Figures 3 and 6). However, WFOs will retain the primary responsibility for ensuring data quality from traditional COOP sites.

- Climatologists at the state offices and at the Regional Climate Centers, operational personnel at the partner agencies, and private sector users will be encouraged to submit their evaluation of data from the modernized COOP network and from the National Cooperative Mesonet through electronic messages to the COMC and possibly NCDC.

- Real-time QA of automated COOP data will occur at the COMC with each datum assigned its own quality-assurance flag before dissemination of the integrated data sets to a broad community of users (Figures 3 and 6). Many of the professional staff at the COMC will be specially trained in advanced procedures of data quality assurance.

- All QA algorithms that operate at the COMC will be standardized and approved through the CCCB while allowing room for flexibility and creativity as new concepts evolve. The NWS, NCDC, and QA personnel at the COMC will be responsible for developing QA algorithms and software (Figures 5-6).

- Based upon automated notifications of suspect data or suspect sensors, QA personnel at the COMC will recommend maintenance actions through the operational Program Manager. The goal for all QA procedures is that they be dynamic to prevent 'bad data' (i.e., data that fail quality assurance procedures) from going public and to assist the operational Program Manager in oversight of network operations (Figures 2, 3, 5, and 6).

- At its discretion, NCDC will determine and perform all post-processing to assess data quality prior to the COOP data entering the national archives (Figure 6).

All maintenance actions will become part of the metadata files for each site and each sensor.

## *D.2 — Metadata*

Metadata are "data about data" which describe the content, quality, condition, and other characteristics of observational data, including any known errors or discontinuities. Metadata document each observing system at the automated sites along with its operating procedures. The metadata files must be organized in such a way to be both easily maintained and accessible.

Relevant information includes: instruments and their serial numbers (including calibration coefficients and location histories), instrument sampling time, calibration dates, validation of sensor performance through on-site visits, station location, exposure, quality assurance flags, local environmental conditions (i.e., vegetation and soil characteristics), and any other specifics that could influence the data history. Digital site photographs (documenting site vegetation, footprints, and overall site conditions) *shall be* dated with each scheduled site visit and made available on-line via one of the COOP web servers. In addition, panoramic or aerial images of each site should be updated every few years to document any changes in fetch (growth of trees on the horizon, encroachment of man-made structures, etc.). Private information about individual land owners will not be made available to the general public.

The operational metadata system may evolve from the current Cooperative Station System Accountability (CSSA). However, shifting the responsibility for metadata and data QA to an independent unit will likely prove advantageous to the operational Program Manager for the modernized COOP and to those who oversee the National Cooperative Mesonet.

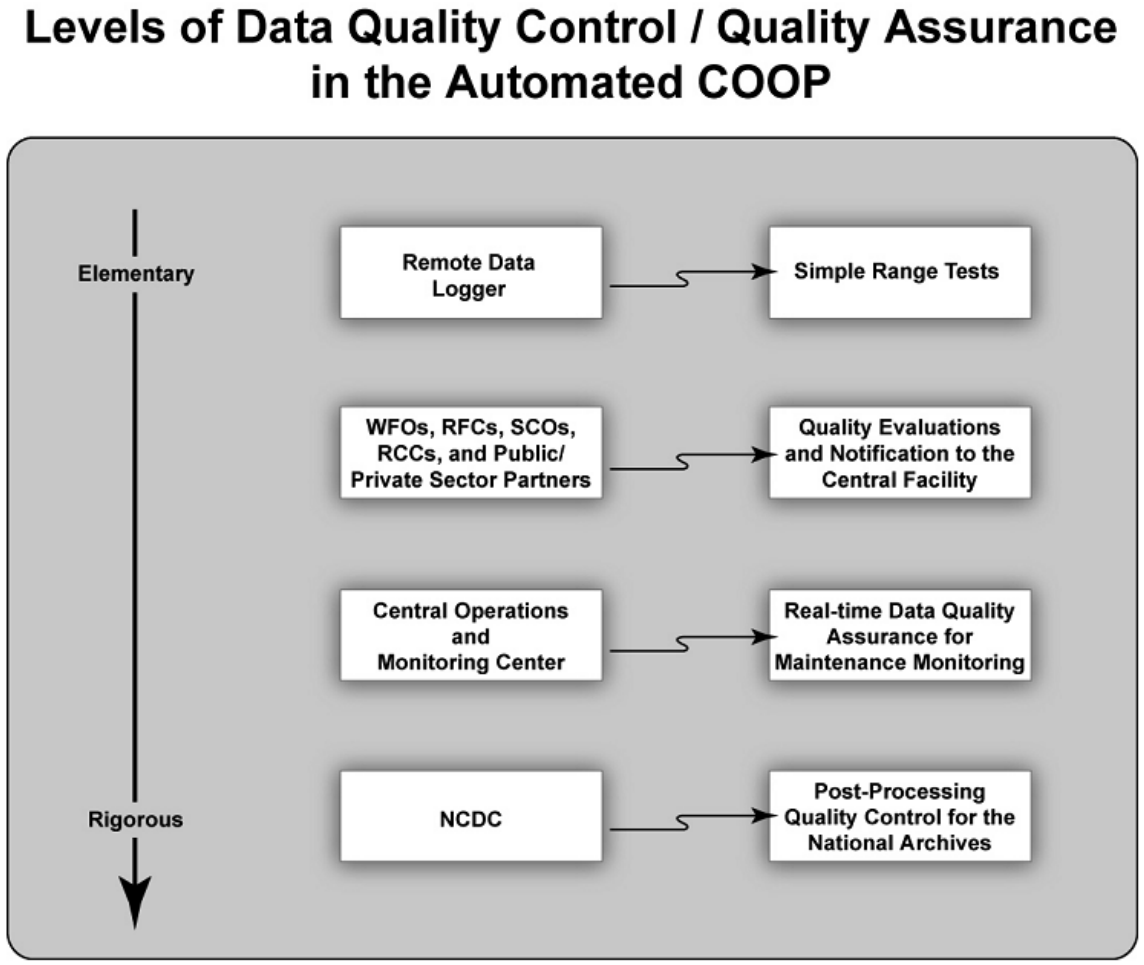


***Figure 6. The levels of data quality control/quality assurance in the modernized COOP***

# *Appendix E — Siting and Observing Standards for the COOP*

## *E.1 — Introduction*

This Appendix provides the standards for sensor siting and sensor exposure in the modernized COOP. It is based on the material referenced below. All observing standards represent longstanding principles of the WMO and the NWS. They have been modified slightly to conform to the metric system for stating the siting and exposure standards.

- NWS NDS Instruction 10-1302 — Instrument Requirements and Standards for the NWS Surface Observing Programs (Land)

  http://www.nws.noaa.gov/directives

- NWS Observing Handbook Number 2 — Cooperative Station Observations
- WMO Handbook Number 8 — Guide to Meteorological Instruments and Methods of Observations
- Office of Federal Coordinator for Meteorology (OFCM) Federal Standard for Siting Meteorological Sensors at Airports (FCM-S4-1994)

  http://www.ofcm.gov/siting/text/a-cover.htm

- Written Guidance from the United States Department of Agriculture
- National Fire Danger Rating System — Weather Station Standards

  http://www.nwcg.gov

The siting and exposure guidance in this Appendix is intended to assist the Regional Site Selection Teams as they seek to determine locations that will help establish automated stations for the modernized COOP. These teams also will be expected to provide recommendations about other networks whose platforms will help build the National Cooperative Mesonet. This guidance includes site information, instrument siting, and instrument exposure for a variety of sensors and site configurations. But, the entire site recommendation and selection process begins by paying close attention to the 'Ten Principles for Climate Monitoring' (Karl et al. 1995; NRC 1998; Appendix E.2).

However, this Program Development Plan also recognizes that many surface observing sites exist (or will come into existence) with a 'less than desirable' exposure when viewed from the perspective of the requirements for a robust climate-observing network. These sites and their networks likely were established to serve specific needs such as roadway observing sites at the top of mountain passes or air quality sites in the middle of urban canyons. Regardless, these special-purpose networks are welcomed additions to the National Cooperative Mesonet.

## *E.2 — Ten Principles for Climate Monitoring*

1. Assess the impact of new systems or changes to existing systems prior to implementation
2. Require a suitable period of overlap for new and old observing systems
3. Treat the results of calibration, validation, algorithm changes, and data homogeneity assessments with the same care as the data
4. Ensure a capability for routine assessments of quality and homogeneity, including high resolution data for extreme events
5. Integrate assessments, like the International Panel on Climate Change, into global observing priorities
6. Maintain long-term stations
7. Put a high priority on increasing observations in data poor regions and regions sensitive to change
8. Provide network operators, designers, and instrument engineers with long-term requirements at the outset of the design and implementation phases of new systems
9. Think through the transition from research observing systems to long-term operations carefully
10. Focus on data management systems that facilitate access, use, and interpretation of weather data

## *E.3 — Sites*

Remote observing sites should be as level as possible, have a natural sod consistent with the region, and be as free from obstructions as possible. The minimum site layout is a footprint that measures ~3 m by 4.8 m (10’ by 16’). *At locations where an enhanced suite of sensors will be or might be installed, which ultimately could prove to be almost all automated COOP sites, the site should be enlarged accordingly*. For example, some sites could one day house 10 m wind sensors, sensible heat flux stations, NDGPS equipment, or PBL radars of the future. It is likely that a majority of automated COOP sites will come to have soil moisture sensors.

Thus, sites may need to be as large as 18 m by 18 m (60’ by 60’). Before sites are recommended for inclusion in the modernized COOP, the Regional Teams must ensure that a proper footprint exists for the possible expansion of the suite of sensors and that the site is suitable for specialized sensors.

Because the obstruction requirements for siting various sensors may be different, the Site Selection Team will be required to use good judgment when a compromise solution is needed.

## *E.4 — Air Temperature and Relative Humidity*

The COOP sensor to measure air temperature and relative humidity (possibly two different sensors) should be mounted at 1.5 m above ground (~5'). If mounted on a tower, a boom should position the sensors ~1.25 m from the tower. The ground below should:

- Be level terrain (earth or sod) and be typical of the area around the station;
- Be at least 30 m (~100') from any extensive concrete or paved surface;
- Be a site with minimal rough terrain and free from gravity-induced flows (water or air) that would produce non-representative temperature data;
- Be a site where water or drifting snow does not collect.

The radiation shelter housing the electronic temperature and relative humidity sensor(s) should not be located closer to an obstruction than four times its height above ground. An object will be considered an obstruction if the object is greater than ten degrees in horizontal width as measured from the sensor and is within ~60 m (200') of the sensor.

## *E.5 — Precipitation Gauges*

The exposure of the precipitation gauge is of primary importance to acquire accurate precipitation measurements, especially snowfall measurements. An ideal exposure would eliminate all turbulence and eddy currents near the gauge that would tend to carry the precipitation away from the gauge. The loss of precipitation in this manner tends to increase with wind speed and orifice height.

The orifice of the gauge will be horizontally level and ~0.6 m (2') above the ground. The gauge site should have protection in all directions by a wind screen of uniform height.

For obstructions on the horizon (defined in Section E.4), their height above the gauge should not exceed twice their distance from the gauge.

## *E.6 — Wind Sensors*

The wind sensor will be oriented with respect to true north. The site should be as level as possible.

The standard height for wind sensors is 10 m (33') above ground. If local restrictions prevent installing the sensors at the WMO standard height, they should be installed no less than 7 m (23') above the ground. However, the USDA likely will ask for a specific height above ground for the wind sensors they might require for evaporation modeling. For example, wind sensors mounted for agricultural purposes may be placed 2 m (6.5') above ground level.

The sensor height must be at least ~4 m (14') above the height of any obstruction located within ~150 m (500'). If practical, the sensor should be at least 3 m (10') higher than any obstruction between 150 m and 300 m (500-1,000') of the sensor. An object will be considered an

obstruction if the object is greater than 10 degrees in horizontal width as measured from the sensor and is closer than 20 times the height of the object.

## *E.7 — Solar Radiation Sensors*

Solar radiation sensors should be mounted where stationary obstructions do not reflect sunlight or cast shadows onto the sensor. They should be mounted 1.8 m (6') above ground level and on the south side of the site plot. While rooftop locations can be appropriate for sensors to measure incoming solar radiation, rooftop locations will not be used in automating the COOP network. This sensor must be mounted horizontally with respect to nadir.

## *E.8 — Siting Requirements for USDA Sensors*

All sites with an enhanced suite of sensors installed for agricultural purposes should be located on federal, state, county, or university land. This agricultural requirement will ensure long-term use of the land for monitoring purposes. When it is not possible to locate these enhanced COOP stations on this type of land, consideration should be given to locate the enhanced COOP sites on land owned by Soil and Water Districts that are cooperators with the USDA.

When selecting a station location, the proposed site should represent the predominant soil type for the region. All "Major Land Resource Areas" in a given climatic region should be represented in the COOP sites selected for automation.

The station must represent the predominant characteristics of an agricultural area. Pasture, range, timber, and cropped areas must be considered first. Generally, stations with enhanced sensors that have an agricultural flavor should not be located near public roads. The first 'agricultural stations' to be installed should be located in areas that are most susceptible to drought. Stations should be located at a distance from obstructions that are compatible with those established for temperature and precipitation sensors.

If the water content of snow is a dominant consideration, stations should be placed in small openings that are ~1 acre in size and surrounded by trees and on land with a slope of 10% or less. A minimum area for a station should be 3 m by 3 m (10' by 10') for a single tower installation. If a snow pillow is required to monitor snow water content, a minimum of 20 m x 20 m (60' by 60') is required. These requirements are intended to mitigate the wind effect.

The area surrounding soil moisture sensors should be kept in the same condition as the natural area, preferably a natural sod. The station should not be located in a drainage area where the natural drainage of the surrounding area would adversely affect soil moisture measurements (e.g., soil moisture sensors on a plot of land that has a slight depression at the sensor site). All enhanced sites with USDA sensors should be located in non-irrigated areas.

To obtain soil samples for use in determining soil characteristics, the soil should be carefully removed from the small hole used to place each soil moisture sensor. Once the sensor is installed, the remaining soil should be returned to its original location (i.e., last out, first in) so as to minimize the healing time between the disrupted soil and the newly inserted sensor.

# *Appendix F — Guidelines for Regional Site Selection Teams*

The Regional Site Selection Teams are vital to the success of the COOP modernization and the building of the National Cooperative Mesonet. These guidelines provide information for the establishment and subsequent of activities the regional teams. It is recognized their assignment will be arduous, will require a rigorous effort, and that a balance must be achieved between three competing issues: the budget available to automate each site, preserving the historical record, and adhering to WMO standards for siting and observing excellence.

## *F.1 — Establishing the Regional Teams*

Teams will be established based on the geographic domains of the six NWS regions. Each Team will have two Co-Chairs:

- One member from the NWS Regional Headquarters
- One member from the Regional Climate Centers

An initial national meeting of Co-Chairs from the Regional Teams will be convened to:

- Charter the Teams by establishing their mission and responsibilities
- Define budgets for the Teams
- Provide training for the Co-Chairs
- Introduce and refine the site selection process
- Introduce the concept of a "pilot site" in a County Warning Area (CWA) of each region to improve the selection process and to serve as a demonstration project. The first task will be to identify the pilot CWA for each Team.

## *F.2 — First Steps of the Regional Teams*

After the initial meeting of the Team Co-Chairs, the Regional Co-Chairs should contact the WFO/RFC for the pilot CWA and notify potential partners of the team's formation.

It is important to include partners such as the USDA and the FHWA (among others) on the site-selection teams from the outset. As part of the selection process, teams must consider future observing requirements that could require an expanded footprint at each COOP site.

Another important selection criterion will be a willingness by the human observers to provide manual elements of snowfall, snow depth and liquid water equivalent of frozen precipitation while allowing the automated sensors to provide all other COOP observations. *Observers who have routine access to the Internet are preferred.* It is recognized that the human observer is, and will remain, the most consistent, yet adaptable observing platform in the world. Even so, the Regional Teams should consider preserving a fraction (100-200) of the *best (and not just the worst)* existing COOP sites as 'traditional' stations, with a human observer taking manual daily observations. For these very special stations, the selection mentality should be "preserve and

augment" (versus "automate and provide humans if possible"). Attaching human augmentation to an automated observation has never been easier and more efficient, and technological evolution will only improve this situation.

## *F.3 — Selection Tools*

The Regional Teams will make extensive use of:

- Digital cameras and handheld GPS devices
- Lists of "institutions of opportunity" (e.g., small community and municipal airports, utility companies, state and national parks, agricultural research farms that are state owned)
- Geographic/geodetic maps, satellite and digital imagery
- Digital Elevation Maps for each state (for hill shade perspectives)
- GIS layers which identify federal, state, county, and university properties. GIS layers for soil types by state and county. GIS layers of climate areas. GIS layers which identify agricultural areas (to include cropped, pasture, rangeland, and forested lands). GIS layers of drought frequency. GIS layers of established climate networks (SNOTEL, SCAN, COOP, RAWS, CRN)

The Regional Teams also must consider:

- Internet availability and reliability at the potential modernized COOP sites
- Communications systems and other established state/local communications networks (e.g., the state LETS networks) that are potentially available for use modernizing the COOP network and in building the National Cooperative Mesonet

## *F.4 — Selection Goals*

- Identify the spatial domain of each grid square that is 20 nautical miles on each side
- Identify the existing COOP stations in each grid square
- Identify non-NWS observing platforms in each grid square that are candidates to become automated sites in the modernized COOP network, or, are candidates to be included in the National Cooperative Mesonet
- Recommend the sites that are appropriate to become Category-3 observing sites in the modernized COOP network. These recommendations should be based upon each platform's siting quality, record of sensor performance, past data availability and data quality, the track record for routine maintenance, and the availability of the required metadata
- Selection criteria also include the length of station history and variety of sensor types, but temperature and precipitation represent the minimum required threshold

- Recommend existing COOP sites that meet the criteria for upgrading to an automated COOP site (Category–2 site)

- Identify grid boxes where 'gaps' exist in the observing network (i.e., those observing units which do not contain an existing COOP site or any non-NWS platform eligible for elevation into the modernized COOP network)

- Identify locations where new COOP sites are needed to complete the modernized COOP network (Category-1 sites)

- Identify only one (1) COOP site in each 20 mile x 20 mile grid box to serve as the automated COOP site in each basic observing unit

### *F.5 — Finalizing the Site Recommendations*

- When partner platforms are likely to be recommended as a modernized COOP platform, the partners should be included in team meetings.

- Platform owners should be contacted to acquire important information on each platform's siting, sensor performance, communications, and the like and to determine a 'willingness to participate' by each platform owner.

- The Regional Site Selection Teams will consider all guidelines for siting and sensor performance provided in the Program Development Plan and the various requirements documents before recommending sites through the 'request for change' process.

- The Regional Site Selection Teams will develop local methods for visiting candidate sites before recruiting and validating those sites.

- The Regional Site Selection Teams will forward the site recommendations (with complete documentation) to the CCCB for inclusion as modernized COOP sites in the National Cooperative Mesonet. The CCCB will provide the Program Office with the categories of sites and actions needed.

- Required 'Memorandum of Agreement' (Appendix I) must be established for all Category-3 sites. Ideally, the RSSTs should secure the MOAs before sending site recommendations to the CCCB.

- After the Pilot CWAs have been used as intended for COOP modernization, the regional Co-Chairs will meet to exchange lessons learned. The lessons learned will be applied and the Regional Site Selection Teams will embark upon this selection process for all CWAs.

- The Co-Chairs of the Regional Site Selection Teams will meet at least annually with the COOP Program Office serving as the host.

# *Appendix G — Alternative Implementation Strategies*

This program plan was written from the perspective that COOP modernization will be an investment for the nation whose dividends will be so large as to almost defy description (Appendix A). The modernization program also was designed for completion within ~5 years after the modernization began to reduce the risk that the continuity of the modernization would be compromised and to reduce the costs associated with operating and maintaining dual COOP networks (beyond the data continuity studies).

However, recognizing the limitations of discretionary funds in the present Federal budget environment, this Appendix outlines two alternative implementation strategies.

The *essential components to any modernization plan* include a recommendation to establish a:

- Program Office for COOP Modernization at NWS Headquarters
- External Advisory Board
- COOP Steering Committee
- Regional Site-Selection Teams
- Central Operations Facility

## *G.1 — Alternative Strategy Number 1: The 75% Solution*

- All components considered essential for COOP modernization (listed above) except…
- Automate temperature observations at about 8000 sites during a ~5 year period
- Provide a spatial resolution for the precipitation sensors that is 60 miles x 60 miles (or $1/9^{th}$ of the fully-funded network)
- Enhance the network with automated precipitation sensors as additional funds permit
- Aim to establish a solid technological foundation to support future growth
- *Impact on the mission of NOAA:* Improvements in hydrologic modeling and flood warnings are compromised. The gridded forecast environment fails to reach its potential. Prediction models for air quality are compromised. Even though NWP models continue to improve, applications-oriented products cannot be developed due to the lack of calibration data. Validation of Quantitative Precipitation Forecasts is seriously hampered. Reduced ability to validate radar-estimated rainfall for runoff models used in ecosystem management. Extending the deployment beyond five years would impact the ability to compare climate records between sites and regions, as some would be modernized while others might not. Does not allow for the establishment of a substantial climate record for precipitation. Reduced opportunities to provide leadership in the development of global-to-local environmental observing systems

## *G.2 — Alternative Strategy Number 2: The 35% Solution*

- All components considered essential for COOP modernization (listed above) except…
- Automate temperature observations at only 4000 *carefully-chosen* sites during a 3-5 year period
- Provide a spatial resolution for the precipitation sensors that is 60 miles x 60 miles (or $1/9^{th}$ of the fully-funded network)
- Establish a solid technological foundation to support future growth
- *Impact on the mission of NOAA:* Distributed hydrologic models cannot be implemented. Drought monitoring is coarse and unevenly distributed. NWP models designed for the storm-scale lack verification data to quantify the improved accuracy of new techniques. Dispersion models cannot be implemented due to the lack of background information (i.e., lack of wind observations) for model initialization. Improved techniques for water management cannot be implemented. A new generation of MOS guidance would be limited to the automated COOP sites and could not be developed down-scale to the resolution of the gridded forecast environment. Greatly reduced ability to provide high-resolution data to first responders in real-time. Decreased opportunities for local communities to be involved in outreach activities associated with a local COOP station. Does not provide opportunities for the growth of a cost-effective energy industry through the use of local data in local forecast models. Significantly limits the ability to provide real-time assessments of mesoscale climate variability (e.g., sub-regional drought monitoring). Reduces the effectiveness of environmental information in transportation applications. Minimizes the ability to increase safety in the nationwide transportation systems. Negatively affects the ability of local forecasters to predict mesoscale, high-impact weather events. Increases the uncertainty of weather-related products that could have provided additional economic benefits to the nation.

## *Appendix H — Partnering/Cost Sharing with the 50 States*

*Real-World Analog for a "State-Run" COOP:* The Interstate highways were constructed individually by states based primarily on federal funds, though a local match was required. As the Interstates evolved, the Federal Government did not come to own these critical roads, did not tell the states how to construct them, nor did they directly oversee their development or their maintenance. The Federal Government simply set standards and provided major funding.

Think of the modernized COOP as the interstate highway system of weather observations. If the Interstate model could be applied to the modernization of the COOP network, the COOP would involve the participation by each state and could become the infrastructure for a national weather network. As a result, a state/Federal partnership for modernizing the COOP network also could become a backbone for meeting local needs, much like the linking of towns along the Interstate system. This *"system of systems"* or *"network of networks"* will become known as 'The National Cooperative Mesonet'.

In the end, this approach to the modernized COOP could be an ideal way to unify all state and locally-owned networks (e.g., transportation and agricultural networks along with urban flood-warning systems, local mesonets, urban micronets, private networks, etc.), provide local oversight of network operations, multiply/leverage the federal investment, greatly increase the political support for COOP modernization, and provide routine access to state-managed telecommunications networks. The latter component would significantly reduce a recurring expense to manage the modernized COOP at the federal level.

*NOAA and the NWS Set the Standards:* This possible implementation concept is based upon NOAA and the National Weather Service formally establishing high-standards of observing excellence. Then, to achieve a desired multiplier effect "of resources available for COOP modernization", the Federal Government could cost-share all components of the COOP modernization on a ratio basis still to be determined (e.g., ~5:1 or 3:1 for initial installations and related 'infrastructure development' but ~1:1 or 2:1 for M&O). The primary leadership for COOP modernization would be at the Federal level as states focused on building their portion of the National Cooperative Mesonet and attaining their required match for the long-term maintenance of the state COOP network.

This scenario increases the up-front funds available for nationwide automation of the COOP network, and — more importantly — substantially reduces the long-term maintenance costs from a federal perspective. Equally as important, grass-roots political support becomes easier to harness. In this scenario, the long-term operation of the modernized COOP and the National Cooperative Mesonet should be simplified as 'local care-takers' oversee critical details that could sink a large network managed and maintained through one contractor or a handful of individuals at NWS Headquarters.

A Central Operations Facility is either Government run or overseen by the Government and is an essential component of the modernized COOP. The recurring salaries for the Central Facility and other NWS support staff are not included in this concept nor are those human expenses at NCDC or at the WFOs. They are considered to be a Federal responsibility.

*Assumptions:* All siting, observing, and maintenance standards are set by the Federal Government and must not be compromised. Federal support is provided only if the agreed-upon standards are met.

*The Basic Idea:* Based upon future negotiations between the Director of the National Weather Service and the Governors of each state, the NWS effectively 'hires' each State (e.g., via a State Climate Office, a State Department of Transportation, or a State Water Board) to maintain and operate a state mesonet in their respective states. How they implement and maintain their respective network is up to the individual offices — as long as the standards set by the Federal Government are continually met. To qualify for Federal support, the respective Governors must pledge to follow the Federal observing standards and to meet all required cost matches.

Fortunately, the matching funds would not all be needed at once, but could be delivered on a state-by-state basis over a decade-long period — to match the available Congressional support of the COOP modernization. This concept implies an implementation on a state-by-state basis.

Private contributions to the COOP modernization are not eliminated in this scenario; they simply are beyond the scope of this first 'airing' of a possible new implementation concept.

# *Appendix I — Templates of MOAs to Share Mesonet Data*

NWS FORM 1307-1 (xx-xxx.xxx)

AGREEMENT FOR COOP CATEGORY-3 SITES
TO JOIN THE NATIONAL COOPERATIVE MESONET

| 1. Platform Owner/Provider/Point Of Contact (POC) | Regional Team — Point Of Contact (POC) |
|---|---|
| Name: | Name: |
| Location: | Location: |
| Phone: | Phone: |

2. Platform Owner will contribute a Category-3 Site by:

2a. Number of platforms?

3. NWS will contribute to Category-3 Site by:

4. Platform owner will provide required Metadata (state how) by:

5. Elements the Category-3 platform provides:

6. Maintenance record of Category-3 (list information available):

7. Record of Data Quality Control by provider (list information available):

8. Documents attached to agreement:

**GENERAL TERMS AND CONDITIONS**
**DURATION OF AGREEMENT, AMENDMENTS, AND MODIFICATIONS**

**This agreement is subject to the availability of funds. This agreement becomes effective when signed by both parties. This agreement will terminate 5 years from the date it becomes effective, but it may be terminated, revised, amended, renewed, or extended for another 5-year period at any time by mutual consent of the parties. Either party may terminate this agreement by providing 30 days written notice to the other party. The Government reserves the right to terminate the agreement immediately at the convenience of the Government.**

**RESOLUTION OF DISAGREEMENTS**

**Should disagreement arise on the interpretation of the provisions of this agreement, or amendments and/or revisions thereto, that cannot be resolved at the operating level, the area(s) of disagreement shall be stated in writing by each party and presented to the other party for consideration. If agreement on interpretation is not reached within 30 days, then the parties shall forward the written presentation of the disagreement to their respective higher officials for appropriate resolution.**

**All information in this agreement shall comply with Weather Service Instruction 10-1309. This agreement allows the NWS to use the data without restriction and for any purpose. Any expenses associated with this agreement incurred by either signatory will remain exclusive to the signatory, unless previously negotiated.**

| For the National Weather Service<br>Signature and Date | For the Platform Owner<br>Signature and Date |
|---|---|
| Name & Title - Printed | Name & Title - Printed |

NWS FORM 1307-2 (xx-xxx.xxx)

# AGREEMENT FOR COMPLEMENTARY DATA PARTNERS OF THE NATIONAL COOPERATIVE MESONET

| 1. Complementary Data Partner/Point Of Contact | NWS Point Of Contact |
|---|---|
| Name: | Name: |
| Location: | NWS Office: |
| Phone: | Phone: |
| 2. Data acquired through: | Internet address (URL): |
| 3. Location of Metadata (URL): | |
| 3b. Type of Metadata available (LAT?/LON?/Elevation?/Site Name, etc.) | |
| 4. Maintenance Record by Provider on Data Collection Platform (attach information available): | |
| 5. Quality Control on Data from Provider (list information available): | |

**GENERAL TERMS AND CONDITIONS**
**DURATION OF AGREEMENT, AMENDMENTS, AND MODIFICATIONS**

**This agreement is subject to the availability of funds. This agreement becomes effective when signed by both parties. This agreement will terminate 5 years from the date it becomes effective, but it may be terminated, revised, amended, renewed, or extended for another 5-year period at any time by mutual consent of the parties. Either party may terminate this agreement by providing 30 days written notice to the other party. The Government reserves the right to terminate the agreement immediately at the convenience of the Government.**

**RESOLUTION OF DISAGREEMENTS**

**Should disagreement arise on the interpretation of the provisions of this agreement, or amendments and/or revisions thereto, that cannot be resolved at the operating level, the area(s) of disagreement shall be stated in writing by each party and presented to the other party for consideration. If agreement on interpretation is not reached within 30 days, then the parties shall forward the written presentation of the disagreement to their respective higher officials for appropriate resolution.**

**This agreement allows the Government to use non-federal data without restriction and for any purpose, unless negotiated otherwise. Any expenses associated with this agreement incurred by either signatory will remain exclusive to the signatory, unless previously negotiated.**

| For the National Cooperative Mesonet<br>Signature & Date | For the Complementary Data Partner<br>Signature & Date |
|---|---|
| Name & Title - Printed | Name & Title - Printed |

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## *Appendix K — Abbreviations and Acronyms*

AASC — American Association of State Climatologists

ACARS — Aircraft Communications Addressing and Reporting System

AMS — American Meteorological Society

BUFR — WMO standard Binary Universal Form for the Representation of meteorological data

CCCB — COOP Configuration Control Board

CFO — Chief Financial Officer

CIO — Chief Executive Officer

COE — U.S. Army Corps of Engineers

COMC — Central Operations and Monitoring Center

COOP — NOAA's Cooperative Observer Network

COTS — Commercial Off-The-Shelf technology

CRN — NOAA's Climate Reference Network

CSSA — Cooperative Station System Accountability

CSC — COOP Steering Committee

CWA — County Warning Area

DCS — Data Collection System

DOT — Department of Transportation

EAB — External Advisory Board

EIA — Electronics Industry Alliance

EOS — Earth Observation System

FHWA — Federal Highway Administration

FRD — Functional Requirements Document

FSL — Forecast Systems Laboratory

GATEWAY — Acronym used to describe the point were digital NWS data are available

GFE — Government Furnished Equipment

GOES — Geostationary Operational Environmental Satellite

HADS — Hydrometeorological Automated Data System

HCN — Historical Climate Network

HPD — Hourly Precipitation Data

JAG — Joint Action Group

LETS — Law Enforcement Telecommunications System

MOS — Model Output Statistics

NCDC — National Climatic Data Center

NCM — National Cooperative Mesonet

NDGPS — Nationwide Differential Global Position Systems

NDS — National Weather Service Directives System

NESDIS — NOAA's National Environmental Satellite, Data, and Information Service

NRC — National Research Council

NOAA — National Oceanic and Atmospheric Administration

NOAAPORT — A satellite delivery system for access to NOAA data

NWA — National Weather Association

NWP — Numerical Weather Prediction

NWS — NOAA's National Weather Service

OAR — Office of Oceanic and Atmospheric Research

OCIO — Office of the Chief Information Officer

OCWWS — NWS Office of Climate, Weather and Water Services

OFCM — Office of the Federal Coordinator for Meteorology and Supporting Research

OHD — NWS Office of Hydrologic Development

OOS — NWS Office of Operational Systems

OSD — NWS Office of Systems Development

OSDPD — Office of Satellite Data Processing and Distribution

OS&T — NWS Office of Science and Technology

PDP — Program Development Plan

QA — Quality Assurance

QC — Quality Control

RAWS — Remote Automated Weather Station

RCC — Regional Climate Center

RCPM — Regional COOP Program Manager

RFI — Request for Information

RFC — River Forecast Center

RFP — Request for Proposals

RSST — Regional Site Selection Teams

RWIS — Road Weather Information System

SC — State Climatologist

SCAN — Soil Climate Analysis Network

SHEF — Standard Hydrologic Exchange Format

SNOTEL — SNOw TELemetry

SOO — Statement of Objectives

TVA — Tennessee Valley Authority

USDA — U. S. Department of Agriculture

USGS — U. S. Geological Survey

WGA — Western Governors Association

WFO — Weather Forecast Office

WMO — World Meteorological Organization

WSR-88D — Weather Surveillance Radar 1988 Doppler

XML — An open standard for representing structured text-based information

# *Appendix L — Attached Letters of Support*

**American Association of State Climatologists**
David A. Robinson, President
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August 20, 2003

Secretary Donald L. Evans
Office of the Secretary
HCHB, Room 5516
U. S. Department of Commerce
14th & Constitution Avenue,
N.W.
Washington, D. C. 20230

Dear Secretary Evans:

As the President and immediate Past-President of the American Association of State Climatologists (AASC), we write to strongly endorse plans by the National Weather Service to lead the modernization of NOAA's Cooperative Observer Network (COOP). We ask that you personally review these newly revised and visionary plans. We trust that they will gain your full support when they move into NOAA and the DOC for consideration as a budget initiative.

This strategic initiative provides the nation with a framework for the real-time measurement and mitigation of the effects of weather and climate on the economy of the United States. The nation faces many critical weather and climate-induced challenges, such as drought monitoring and mitigation, air quality assessment, estimates of agricultural production, energy management, homeland security, the effects of weather extremes on society, and the detection of changes in weather patterns over time. This plan moves an aging and overtaxed climate network into the 21st century by automating and integrating climate stations nationwide to meet hundreds of thousands of user needs.

Let us provide a bit of history. The modernization of the COOP network has been proposed as a new initiative within NOAA for more than a decade, but the progress has been minimal. Without the required investment, the program is in danger of becoming unreliable for local climate monitoring, a key strategy for assessing climate impacts and risks, and for making society less vulnerable to extreme weather conditions.

Today, the stations have antiquated equipment, maintenance is unable to keep pace, and the observations are becoming more questionable by all users. With more than a 100-year legacy and recommendations for a fully modernized network by many groups (including our own National Research Council), the nation cannot afford to squander this national treasure. Maintaining the old network is in serious jeopardy, and is now going past the stage of no return where climate records will soon be irrevocably lost due to an antiquated observing system. This situation is most unfortunate and represents a potential national embarrassment.

At our annual meeting during the first week of August, we were briefed on the revised COOP modernization plan about to surface within the National Weather Service. We believe the new vision is a technologically wise and economically sound investment for the nation. Our attachment lists a few of the many economic dividends that will accrue as a result of COOP modernization.

We strongly endorse these new modernization plans and trust that they will gain your full support as well.

Sincerely,


Professor David A. Robinson
New Jersey State Climatologist
President of the AASC
Center for Environmental Prediction
Rutgers University

Professor Roger A. Pielke, Sr.
Colorado State Climatologist
Immediate Past President of the AASC
Department of Atmospheric Science
Colorado State University


Attachment

Cc:
Deputy Secretary Samuel W. Bodman
VADM Conrad C. Lautenbacher, Jr., US Navy (Ret.)
Brigadier General John J. Kelly, USAF (Ret.)

R M S

Risk Management Solutions, Inc.
7015 Gateway Boulevard
Newark, California 94560
tel 510-505-2500
fax 510-505-2501
http://www.rms.com

October 13, 2003

Secretary Donald L. Evans
Office of the Secretary
HCHB, Room 5516
U. S. Department of Commerce
14th & Constitution Avenue, N.W.
Washington, D. C. 20230

Dear Secretary Evans:

As the world's leading provider of products and services for the management of catastrophe risk, Risk Management Solutions Inc. (RMS) strongly endorses new plans by the National Weather Service to modernize NOAA's Cooperative Observer Network (COOP). The implementation of this program — which we understand will help build a National Cooperative Mesonet — will address substantial data voids that currently exist for the quantification and transfer of weather and catastrophe risk. We ask that you strongly consider risk management applications as you continue the planning and design phases of the modernization and that you allow RMS to provide input in this process.

Reliable, high-density weather observations provide that basis for the quantification of risks from hazards such as hurricanes and extratropical cyclones. These observations can also enable the transfer of risk between the insurance industry and the financial markets through securities such as Catastrophe ("Cat") Bonds. Over the long term, accurate and reliable weather observations enable or enhance the weather risk market.

There are two clear weaknesses that exist in the current capability to collect weather data (wind speed and precipitation) during extreme wind events: the interruption of data from power losses during extreme events and the low geographic density of observations, particularly along the coastline. We feel that the modernization of the COOP program has the potential to eliminate these limitations.

We strongly endorse the COOP modernization plan and request the opportunity to participate in future stages of this initiative.

Sincerely,

Auguste Boissonnade, Ph.D.
Vice President, Research and Model Development

C: Commerce Deputy Secretary Sam Bodman
NOAA Administrator Lautenbacher
NWS Director Kelly