

NRSP Proposal Format

Project Title: NRSP3: The National Atmospheric Deposition Program (NADP)

Requested Duration: 10/01/2024 to 09/30/2029

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Non-Technical Summary

The National Research Support Project-3 (NSRP-3) is a long-term project designed to provide research quality data to SAES scientists to address many national needs, agricultural grand challenges, and research needs. Our primary goal is to measure the rate of pollution deposition onto U.S. agricultural lands (i.e., pollution falling onto the surface with precipitation). We measure the deposition rate of sulfate, nitrate, ammonium, chloride, major cations, and H⁺ (pH) at over 250 locations, and ammonia gas concentrations at 100 sites to estimate dry deposition (through gravitational settling). These measurements are made weekly/biweekly and with standard methods at all sites, and principally for research purposes.

Our data is provided in weekly measurements, monthly, seasonally, and annual averages, is quality assured, and is all available free of charge (see <https://nadp.slh.wisc.edu/>). This data is used for research, policy decisions and education (primary to graduate). Agricultural scientists use our data in many different types of research; a few examples include understanding chemical movement (nitrogen, other) associated with fertilizers and animal feeding operations, basic data for many agricultural models to understand new techniques and estimate environmental impacts, for evaluating ammonia emission impacts on non-agriculture environments, trends determination over time, etc. Many other nonagricultural scientists use our data as well.

Our results are used in approximately 200 journal articles per year, meeting the NRSP research support role.

Finally, NRSP-3 funding is highly leveraged with other federal, state, and tribal agencies, and other groups to provide this national scale data for all scientific purposes and research.

Statement of Issues and Justification:

Prerequisite Criteria:

A. How is the NRSP consistent with the mission? (8,000 characters)

National Research Support Project-3 (the National Atmospheric Deposition Program, or NADP) provides a national and international monitoring cooperative to measure the flow of air pollutants into all managed agricultural systems and all other environments over the United States and Canada. Through this cooperation, a research database of pollutant concentration measurements in precipitation and downward fluxes has been developed (since 1978 and at 251 current sites), which supports significant and important agricultural research in several specific areas (collection, assemble, storage, distribution, information, etc.). This cooperative approach directly supports the NRSP mission, by providing basic chemical measurements of sulfur, nitrogen, chloride, and other cations into agricultural systems for researchers to use. All of these compounds are or could be important in many agricultural settings, so the NRSP-3 thereby supports a wide array of agricultural research activities in any number of ways (e.g., Grand Challenges, see below) and supports many other types of environmentally-connected research simultaneously.

NRSP-3 provides a collaborative framework for participating scientists from State Agricultural Experiment Stations (SAES); universities; federal, state, local, and tribal government agencies; national forests and laboratories; environmental institutes; private companies; and other research organizations who cooperate in sponsoring NADP measurement networks. We support the NRSP mission by providing agriculturally-related data that can be used at any and all SAES, any land-grant university (1862, 1890, 1994), and allows for SAES/agricultural scientists to cooperate more easily with researchers from different departments, colleges, universities, and government institutions. Finally, this data is provided to researchers free of charge.

The NADP provides the only regional and national-scale data and information on the amounts, geographic distribution, and trends in chemical deposition by precipitation in North America. The NADP operates five networks which support differing research goals and areas of interest. For this proposal, the agricultural community primarily cooperates in two large networks: the National Trends Network (NTN) and the Ammonia Monitoring Network (AMoN). Specifically, the NTN provides weekly concentrations in precipitation of free acidity (H^+ as pH and concentration of this ion), specific conductance, nitrate (NO_3^-), ammonium (NH_4^+), sulfate (SO_4^{2-}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), and chloride (Cl^-). The AMoN provides two-week atmospheric concentrations of ammonia gas (NH_3). These compounds are important for agricultural research and therefore can be used in any number of research areas and projects, as is shown year in and year out in our output statistics and project results.

The NRSP-3 research database of these two networks (NTN, AMoN) now includes over 600,000 measurements of precipitation chemistry, extending from 1978 to mid-2023. Each of these records has an observation of each previously listed chemical component, the amount of precipitation for the week, a valid or invalid measurement determination, and a date and time of the measurement, all for over approximately 300 monitoring locations. Finally, the 53 SAES-associated stations have the longest continuing records since most of these sites were the original NRSP-3 sites in the network. Almost all these sites have 40+ year historical records.

Distribution of NRSP-3 data is through a web-accessible database, where **all** scientists and data users have access to all data available, meaning no data or information is sequestered. It is a truly publicly available database for anyone to use (research, education, or policy, see <https://nadp.slh.wisc.edu/>).

The NRSP-3 has demonstrated flexibility and response to the current and future national needs of the research community for information over a broad array of scientific topics. These topics include the effects of atmospheric deposition on terrestrial and aquatic ecosystems, biogeochemical cycling, climate change, and human health. NRSP-3 data support informed decisions on air quality issues related to precipitation chemistry and atmospheric deposition. NRSP-3 also directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), and particularly Grand Challenge 1, 2, 3 and 6, and partially 4 and 5. In general, NRSP-3 information has been invaluable in:

- Documenting the presence and removal of inorganic pollutant gases and aerosols in the atmosphere (i.e., the United States' "chemical climate");

- Documenting how atmospheric chemicals are changing in amount and relative composition over time (trends determination);
- Understanding the effects of atmospherically-deposited chemicals on agricultural crops, national and state and private forests, rangelands, surface and ground waters, estuaries, aquatic impoundments, and other natural resources;
- Documenting the flow of agricultural nitrogen, evaluating new agricultural methods to control the release of nitrogen from cultivated fields and crops into waterways and the atmosphere, tracing gaseous ammonia emissions and movement from agricultural operations, satellite-based tracking of NH₃ in the atmosphere from source to sink, and used in many other agricultural modeling efforts;
- Assessing the accelerated weathering of material and cultural resources resulting from atmospheric chemical deposition;
- Discerning pollutant sources and source distributions and their relationships to deposition (i.e., source-receptor relationships); and
- Evaluating the effectiveness of current Clean Air Act (CAA) legislation and subsequent rules promulgated under the act, and the impact of atmospheric deposition on water quality requirements set by the Clean Water Act.

B. How does this NRSP pertain as a national issue? (10,000 characters)

As stated previously, the NRSP-3 directly supports many national priorities and Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), particularly for the Challenge 1, 2, 3 and 6, and partially 4 and 5. It also supports these for all SEAS regions and stations.

Use by multiple locations/regions: Since its 1977 founding as NC-141 by the SAES, NRSP-3 has offered a unique opportunity for cooperation among scientists from land grant and other universities, government agencies, and other organizations. It provides a framework for leveraging the resources of over 100 sponsoring agencies to address current and emerging national issues. Within the networks, 54 NADP sites are either sponsored or operated by SAESs, located at land-grant universities, or are run by ARS scientists. These 54 sites are located in all four SAES regions, with 41 of 54 sites having a 40+ year operating record and therefore, represent almost all of the longest-running precipitation chemistry sites in the world.

Addressing National Issues:

Over the 40+ year existence of NRSP-3, several relevant national issues have been addressed by NRSP-3's collected data.

Originally, the SAES North Central Region established NC-141 to address "Chemical Changes in Atmospheric Deposition and Effects on Agricultural and Forested Land and Surface Waters in the United States" (2). The objectives were to a) "establish an atmospheric deposition network for measuring beneficial nutrients and potentially injurious substances in precipitation and dry particulate matter" and to b) "organize and coordinate research on atmospheric deposition effects". The initial focus has been on the pH of precipitation, and principally sulfate ion (linked directly to emissions from coal combustion).

The NC-141 initiated the collection of one-week integrated wet-only deposition in 1978, and quickly had operating sites in all four SAES regions. Organizing the efforts were principally SAES scientists, federal and state agencies, and university scientists. Justified by the potential for human activities to affect atmospheric chemistry and, in turn, the nutrient status of terrestrial and aquatic systems (3-5). In 1980, a 10-year program entitled the National Acid Precipitation Assessment Program (NAPAP) was launched (6) as the National Trends Network (NTN), which ultimately merged with the existing NADP as NADP/NTN (6, 7). One review panel concluded: "The monitoring program and resultant data (i.e. NRSP-3) that is being constructed is perhaps the most significant, long-term, continuous, and comprehensive sampling and analysis program to be undertaken in the environmental sciences" (8).

SAES Directors have renewed the resulting NRSP-3 program through several iterations from 1992 through 2023, given that NRSP-3 has shown, through scientific measurement, that:

- Chronic chemical loading from atmospheric deposition can result in long-term changes,
- There is significant acidic sulfate and nitrate decrease nationwide (9),
- No evidence has shown that acidic precipitation at ambient U.S. levels is responsible for regional crop yield reductions (10),
- Ambient deposition in high-elevation eastern-U.S. forests is altering nutrient status leading to growth reduction, frost intolerance, or decline of these ecosystems (10),
- Acidic deposition is causing long-term chemical changes in soils (10),
- Atmospheric sulfate deposition results in some poorly buffered surface waters becoming more toxic (11),
- Acidic deposition increases the corrosion of metals and alloys (12).

These overarching results detail explicitly several *national issues* of concern; chemical changes to agricultural/all soils, changing precipitation concentrations over the U.S., impacts to all forests of concern to USDA-Forest Service and National Park Service, chemical changes in water quality (drinking water included), and impacts to structures (stone, metal, etc.). The NRSP-3 addresses all these national concerns directly, by providing weekly measurements of the concentration and flux of precipitation pH, chemical conductivity, and eight chemical constituents.

Here are some brief examples of how NRSP-3 functions to meet other national needs and science.

Acidic Precipitation:

- *The Clean Air Act Amendments of 1990 (CAAA-90) sought “to reduce the adverse effects of acid deposition through reductions in annual emissions of sulfur dioxide (SO₂) and nitrogen oxides (NO_x).”* The Act required monitoring and reporting the effect of these emissions reductions on deposition (13). The NTN has been used to show dramatic decreases in sulfate deposition, where several reports have shown that agricultural professionals are now needing to add S into fertilizers now, since it is no longer being deposited in rain. (14)
- NTN measures the wet deposition of both NO₃⁻ and NH₄⁺. Many recent papers have shown that NO₃⁻ is now the most important pollutant driving acidification in precipitation (15), given the strong sulfur reductions. However, with precipitation remaining acidic (<https://nadp.slh.wisc.edu/maps-data/ntn-gradient-maps/>), researchers have now focused on total N deposition. Therefore, NADP is still measuring the main forcing mechanism of acidic precipitation. Agriculture and fertilizer use is a major source of the N compounds in precipitation.
- Li, et al. (2016) showed that atmospheric N is no longer dominated by nitrogen oxides (from fossil fuel combustion) but by reduced N forms. These results used NRSP-3 data. Now, the largest contributor to N wet deposition is reduced N compounds, such as organic nitrogen and particulate ammonium converted from emissions of ammonia gas (NH₃). *Again, a major source of both of these categories is agricultural activity (fertilizer, animal feeding operations, waste lagoons, etc.).* Therefore, more agricultural researchers are focusing on reduced N deposition.

Nitrogen Fertilization, Species Diversity, and Invasive Species

- Many scientists have shown the connection between N deposition and species changes in the natural environment, and to changes in the USDA-controlled national forests. N enrichment could be decreasing both species diversity and abundance of plants (16).
- Since in many agricultural situations, N is used as a fertilizer, many of our recently noted agricultural articles have used NRSP-3 data in nitrogen balance questions in agricultural research (e.g., 17). Many researchers are looking for the importance of deposition in agricultural situations and looking at how new agricultural practices will affect N flow and biogeochemistry. (18).

National Issue of Air Quality

Trends in nitrogen species have not demonstrated the same consistency as sulfate wet deposition. Although NO_3^- concentrations have decreased in the Northeast since the mid-1980s, significant increases have occurred in the Great Plains and Rocky Mountain states (19-22). Increases in NH_4^+ ion over the same period have been nearly as widespread as sulfate decreases (20). These trends are illustrated in NADP year-to-year map animations (<http://nadp.slh.wisc.edu/data/animaps.aspx>). These ammonia trends have continued (23, 24), emphasizing the importance of agriculture participation in national-level studies with the predominant source of NH_3 originating from agricultural sources.

Continued Importance of Ammonia/Ammonium

The importance of NH_3 emissions to the atmosphere continues, particularly in the central U.S. This relationship to agricultural sources is well documented by many agricultural scientists (e.g., 25). In response to early indications, NRSP-3 established the AMoN to measure ambient gaseous ammonia concentrations. Over the past 10 years, the AMoN has grown to a national network, measuring NH_3 at approximately 100 sites. AMoN data continue to be useful to agricultural scientists used to better understand the emission, impact and dry deposition of NH_3 . The AMoN represents the first consistent, long-term regional/national measurements of gaseous NH_3 , and AMoN measurements will provide a baseline for evaluating subsequent reductions.

A new research paper released this month (26) demonstrates with satellite data that atmospheric NH_3 is an international issue of great importance and focuses on the lack of gaseous measurements in the U.S. They specifically call for more NH_3 gas measurements in the rural U.S., given the rise in animal production. This article

supports continued agricultural measurement in the AMoN network, and the use of its data by agricultural scientists.

New Measurements Planned to Address Other National Needs:

- Algal Blooms have become a major environmental problem in recent years and have been featured in a multiple national news stories. Algal bloom has been associated with phosphorus addition to P-limited lakes, with P likely from the atmosphere (27). Atmospheric P measurements are needed to understand these algal blooms and the connection to agriculture since it is a very large user of P and likely a large source contributor to lakes, rivers, and water impoundments (e.g., Lake Erie). Many recent publications are calling for national total P measurements in the atmosphere (28). NRSP-3 is currently developing a measurement method for Total P in precipitation as discussed in other sections.
- Algal Blooms and Total Nitrogen. Many algal bloom situations are limited by N and partially by N deposition. Recently, increases in NH_4^+ wet deposition have been shown. NRSP-3 is currently developing a measurement method for Total N in precipitation. This will allow scientists determine total loading of N more accurately to algal bloom situations.
- Organic Nitrogen in the Atmosphere. The contribution of Organic Nitrogen (ON) is currently unmeasured and will be estimated as part of Total N measurement. The importance of quantifying ON in the atmosphere has become important to both air quality scientists and agricultural scientists (e.g. 29). It is thought that up to 25% of atmospheric N is in the organic form and not routinely measured. NRSP-3 is developing a plan to add a total N measurement and using subtraction $\{\text{ON} = \text{TN} - (\text{nitrate} + \text{ammonium})\}$, estimate the ON concentration in all samples. Secondary samplers have been developed for use by any/all NTN sites that can be used to make this measurement. This method should be ready for field trials in the next few months and will be offered to all NTN sites. The sources of ON clearly include agricultural activities.

Other National Issues

- Studies have connected atmospheric N deposition to estuarine eutrophication and related low dissolved oxygen concentrations and losses of aquatic vegetation (24, 30). Other studies have reported alterations of species richness and diversity of soil flora (31). Increasing N deposition trends in the West have heightened concerns over the potential effects of nutrient additions in alpine and subalpine areas in the Rockies and Cascades (23).

- *Phakopsora pachyrhizi*, commonly called Asian Soybean Rust (ASR), was first reported in the continental U.S. in November 2004. ASR is an obligate fungal parasite thought to rely on a living host (e.g., legumes such as soybean) for survival (32). ASR spreads through aerial dispersal and deposition of urediniospores, which can be transported widely before being deposited by precipitation. With support from the Agricultural Research Service (ARS), NADP collected NTN samples over five years through 2010 (nadp.slh.wisc.edu/educ/asr/, 33-36). These studies demonstrate the application of this NRSP in tracking many different airborne pathogens in U.S. agricultural crops.

Specifically, to the support of other NRSPs, the NRSP-3 data is certainly available to all other NRSPs. However, it is not known if any of them use our data. Nonetheless, we provide data that should be useful to other NRSPs, such as P, N and S input rates that are coming in naturally to U.S. agricultural lands. One would think NRSP-3 data would be particularly important to *NRSP11: Building Collaborative Research Networks to Advance the Science of Soil Fertility: Fertilizer Recommendation Support Tool (FRST)*. This model certainly would benefit in many situations from atmospheric input measurements that NADP provides. We will make an effort during this year to let NRSP 11 know of our data, and invite them to join with us at our next annual meeting for further discussion and collaboration.

Overall, the NRSP-3, with its structure, scientific direction, and site locations around North America can be used to make many fundamental measurements in a wide variety of ways to measure the moment of chemical or lifeforms in many new ways to support many challenges to agricultural researchers.

Rationale:

NRSP-3 directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), and specifically Grand Challenge 1, 2, 3 and 6. NRPS-3 also supports Challenges 4 and 5.

Grand Challenge 1 “We must enhance the sustainability, competitiveness, and profitability of U.S. food and agricultural systems.”

The NRSP-3 directly supports to sustainability and profitability of the U.S. food and agricultural system. This support is provided by:

- NADP supports sustainability of the food system, through the monitoring of pollutants that are emitted from agricultural operations, and therefore promoting efficiency and reduction of environmental damage. One specific pollutant here is

nitrogen pollution, and specifically ammonium, ammonia and organic nitrogen (this next year). We measure these compounds in both precipitation and as atmospheric gases, as detailed in many research activities pursued by agricultural scientists. Pollution of the surrounding environment is not a sustainable process, and agricultural scientists are studying new methods to control these emissions. NRSP-3 can monitor for the current emissions, and current observations can be used to monitor emissions over time to determine when the issue is becoming more sustainable (fewer impacts).

- NADP has a role in the monitoring of N loss from animal feeding operations and waste facilities (ammonia, organic nitrogen), and tracking the impact upon the surrounding environment.
- NADP supports competitiveness and profitability through an increase in nitrogen use efficiency and less losses of nitrogen to the environment.
- NADP also monitors for some of the phosphorus compounds, heavily used in agricultural operations (fertilizers), by measuring the growing amount of P in the atmosphere and in deposition, leading to research designed to reduce the presence of phosphorus.

Grand Challenge 2 *“We must adapt to and mitigate the impacts of climate change on food, feed, fiber, and fuel systems in the United States.”*

- NRSP-3 monitors climate and climate change by monitoring precipitation at approximately 300 sites across the U.S. Therefore, we monitor one of the principal factors of climate change (e.g., precipitation changes).
- As precipitation changes occur, the “chemical climatology” will likely change. Concentration of pollutants is a direct result of the volume of precipitation, and changes in precipitation (volume) will result in chemical concentrations in the atmosphere. The same is true for deposition rates, which are based on the amount of precipitation that falls. If precipitation depth changes, then deposition rates also will change.
- The above two changes will result in a change in chemical flow to the agricultural lands of the U.S., and NRSP-3 is in place to measure any differences that can be attributed to changes in precipitation.
- Many atmospheric chemistry reactions are temperature dependent (e.g., nitrogen compounds). Many scientists expect higher levels of ozone in the atmosphere, which could accelerate the deposition of the resulting pollutants. NADP measures some of the resulting compounds from ozone reactions.
- With expected increasing temperatures, more cooling will be needed (in U.S. and abroad), and in much of the world, the electricity demand will be met with increasing combustion of coal/natural gas (i.e. India, China). Coal contains many

of the pollutants that we measure (e.g., S, N, mercury), and with increasing cooling, a result should be an increase in the deposition of these pollutants. NRSP-3 will be used to track these changes.

- Wildfires and prescribed burns are expected to continue to increase under warming/drier climate scenarios. The NADP's long-term data record can be used to assess the impacts from smoke, biomass burning, carbon cycling, and other disturbances on air quality and agricultural systems.

Grand Challenge 3 *"We must support energy security and the development of the bioeconomy from renewable natural resources in the United States."*

- By tracking the movement of S and N compounds, we are documenting the change in atmospheric chemistry and deposition to lands, as the evolution of increasing energy production and electrical needs move from coal based (high S content) to natural gas (low S content) and biofuels.
- As biofuel research and production begins, this will include combustion of compounds within the biofuels (S, N, P, etc.), and any changes in the wet deposition from these activities will be monitored and recorded by the NRSP-3.
- As biofuel production begins, this will require adaption of agricultural procedures and these adaptations could have impacts upon deposition to surrounding environments. The NRSP-3 will be in place to measure any increases or *decreases* of these impacts.
- With the increased electrification of the transportation fleet, more power will be needed. These transportation emissions will be transferred from urban corridors (vehicles) to rural locations where the production of electricity is generated from biofuels. If any change and movement of these pollutants should occur, NRSP-3 will record that signal, providing required information for agricultural researchers looking for impacts from these changes.

Grand Challenge 4 *"We must play a global leadership role to ensure a safe, secure, and abundant food supply for the United States and the world."*

Work done in the past has shown the movement of agricultural diseases through the atmosphere. If these diseases are water soluble, the NRSP-3 can be used to show their movement, as we did with Asian Soybean Rust spores. NRSP-3 could be used to monitor movement of any number of biological bodies, spores, etc. In the past, we have proposed to use the assets of the NRSP-3 as an airborne crop disease monitoring network. The NRSP-3 is a network for observation network (infrastructure, sampling media, site operators), and the right scientific techniques allows this observational data to be used for many different agricultural applications.

Additionally, the NADP data could be used to monitor the increased use of fertilizer and herbicides/pesticides, which are all likely to be required with increasing food needs. Herbicides/pesticides have been found in precipitation, and NADP could be used for this type of network (given other quality assurance considerations) with scientific support from our members.

An open agriculturally related network also will allow for easy applications of these types of approaches with the scientists of the SAES system.

Grand Challenge 6 *“We must heighten environmental stewardship through the development of sustainable management practices.”*

It seems rather obvious for Challenge 6 that almost every research article using our data are focusing on this Grand Challenge. This is true for the overwhelming majority of the approximately 1000 articles have used NRSP-3 data in their research over the past five years (see <https://nadp.slh.wisc.edu/pubs/Annual-Data-Summaries/>). It is the case that all the articles mentioned in this proposal supports this Grand Challenge.

Other Challenges Addressed: This listing of grand challenges addressed by NRSP-3 does not discuss the issue of mercury contamination of the soils and fish or the impact to the health of the nation. The three NRSP-3 networks concerned with the movement of mercury (Mercury Deposition Network, Atmospheric Mercury Network, Mercury Litterfall Network) do provide meaningful research data direction to address the Science Roadmap Grand Challenges 4 and 5, concerning health of the national food supply (e.g., mercury moving into the food chain of fish). Fish are principally harvested, but aqua culture is increasing in importance. Fish consumption is important to many subpopulations, particularly coastal states, and native American subsistence populations.

Overall, one of the principal advantages of the NRSP-3, is that it is a science-based observation network. With its structure, scientific direction, and site locations around North America, the NRSP-3 can be used to make many fundamental measurements in a wide variety of ways to measure the temporal and geographical impacts of both chemical and biological effects in support of agricultural research. It is structured for agricultural scientists to make these needs known and to test these ideas out relatively quickly through the NRSP designation.

B. Relevance to stakeholders: (8,000 characters)

NRSP-3 provides a collaborative environment to leverage the fiscal, material, human, and intellectual resources of scientists, educators, and policymakers from SAES, universities, government agencies, and non-governmental organizations. Stakeholders include:

- Sponsors that pay for NADP site costs, site operations, etc.
- Site operators contributing efforts in sample collection.
- Cooperators that provide land, electricity, laboratory/office space, and shipping.
- Scientists who use and present NADP data.
- Educators who use NADP data in their classrooms or textbooks.
- Students who use NADP data in the classroom or graduate studies.
- Policy makers who use NADP data to make informed policy decisions.

All program stakeholders are invited to attend twice-yearly subcommittee meetings in the spring and fall, (~ 75 individuals). Subcommittees receive status and progress reports on network activities, review operations and documents, consider procedure and equipment changes, and propose new initiatives. Many stakeholders are officers and ad hoc members of the committees and subcommittees. The NADP *Quality Management Plan* calls for triennial network laboratory reviews, with reviewers drawn from stakeholders.

The Executive Committee (EC) seeks to engage stakeholders in NADP activities. Recent interest has led to investigation of using the NADP to support citizen science, development of the Total N and P measurements, and the breadth of mapping by the Critical Loads (CLAD) subcommittee.

Since 2011, the Total Deposition subcommittee (TDEP) has developed a new map series of total deposition of N and S through a measurement and modeling “fusion”. TDEP has been vigorously updating their mapping series and continues to bring in new membership (see reference 37 and <https://nadp.slh.wisc.edu/committees/tdep/>).

In the last several years, Aero-allergens (pollen) have been stirring interest among several cooperators and a new scientific AMSC subcommittee was established (<https://nadp.slh.wisc.edu/committees/amsc/>). AMSC has brought in new members primarily from the health community, with intention of using NADP networks as a national atmospheric pollen monitoring network. This effort has made significant progress (38) with the possible use of new technologies in a network. This effort is of

interest to many agricultural researchers, since there is a connection between pollen and agriculture.

Stakeholders in the research community can submit a simple proposal to use archived NADP samples for additional research. Researchers are encouraged to attend NADP meetings and present their findings. This has sparked new discussion and new research. Recent research studies include:

- Applying O¹⁸ and H² measurements to examine the relationship between precipitation and surface and ground water sources. (39-41)
- Using N¹⁵ measurements to infer atmospheric NO_x sources. (42)
- Testing for the presence of potentially hazardous chemicals. (43-46)
- Investigating organic nitrogen inputs to total deposition.
- Measuring dissolved Si to understand loads to surface waters in the Midwest.

Stakeholder use of NADP data is assessed by recording website activity, requesting annual participant reports, and performing regular literature searches. This information is summarized in SAES-422 and USDA AD-421 reports.

Internet disbursement of precipitation chemistry and atmospheric data is the primary route of NRSP-3 data and information. From 2018-2022, NADP estimated over 20,000 measurement data sets were downloaded each year, and approximately 50,000 PDF map images and 100,000 map data sets (grid and kmz). As far as we know, downloads continue to occur at roughly the same rate over the last five years, suggesting that NRSP-3 remains relevant.

Each year, NRSP-3 summarizes research that develops in whole or in part from NADP data. During the last three years, publication counts have remained high relative to historic counts (since 2007) at about 220 per year. However, 2022 was rather low (183), which may be due to COVID-19 implications. Assuming 2022 was unusual, research use in publications remains consistent, and, again, signals that the NRSP-3 data remains useful and relevant for research support.

NADP data are frequently used to inform and evaluate environmental policies and agreements. NADP maps are utilized in US EPA materials for acid rain deposition and educational materials (<https://www.epa.gov/acidrain>), and total deposition values mapped by EPA's CASTNET (<https://www.epa.gov/power-sector/progress-report-acid-deposition>), and annual reports (47). Federal land management agencies also use this data for decisions involving regional haze, critical load estimates, general conservation, climate change decisions, and management of timber resources. NAPAP reports to

Congress used NRSP data in assessing emissions changes on deposition on aquatic and terrestrial systems (48). The International Joint Commission uses NADP data in its periodic evaluations of the U.S.-Canada Air Quality Agreement (49) and the Canadian government's deposition assessments (50). Additional regional and state policy assessments, environmental impact statements, and numerous other reports use our data as well (<https://nadp.slh.wisc.edu/pubs/nadp-bibliography/>).

Each year, articles with agriculture importance are detailed in the NADP's SAES 422/NIFA REEport. Here are three examples from 2021 and 2022:

1. Zhang, J., Cao, & Lu, 2021. Half-Century History of Crop Nitrogen Budget in the Conterminous United States: Variations Over Time, Space and Crop Types. *Global Biogeo. Cycles* 35(10): e2020GB006876.

Crop nitrogen budgets are important to agricultural research, and the authors used multiple datasets to examine N budgets for eight major crops in the U.S. at county scale between 1970 and 2019. The authors concluded that N use efficiency has increased from 0.55 kg N/kg N in the 1970s to 0.65 kg N/kg N in the 2010s. Corn, rice, cotton, and sorghum have increased in efficiency, while barley, durum wheat, spring wheat, and winter wheat have decreased. Iowa State University researchers used 16 years of national NTN nitrogen deposition data to estimate total N deposition for every county in the U.S.

2. Bhattarai, A., Steinbeck, Grant, Kalcic, King, Smith, Xu, Deng, and Khanal, 2022. Development of a calibration approach using DNDC and PEST for improving estimates of management impacts on water and nutrient dynamics in an agricultural system. *Env. Mod. & Software* 157: 105494.

The authors (Ohio State, ARS) focused on a modeling study of the biogeochemical DeNitrification DeComposition (DNDC) model in an agriculture situation in Ohio. The goal was to test three model calibrations to determine which was best. They also tested the effectiveness of the PEST parameter estimation software. Several model parameters were shown to be very influential, while corn yield was most sensitive to accumulative temperature and grain carbon to nitrogen ratio. The researchers used repeated years (2014-2020) of NADP's weekly data from a NE Ohio site (IN41).

3. Waiker, P., Ulus, Tsui, and Rueppell, 2022. Mercury accumulation in honey bees trends upward with urbanization in the USA. *Ag. & Env. Letters* 7(2): e20083.

With this very interesting idea, the authors theorized and found that honeybee (*Apis mellifera*) mercury concentrations, in part, were explained by the urbanization of the landscape. In their small sample, they did find that honeybee concentrations tend to increase with urbanization, although the low sample numbers. Methyl mercury (organic Hg form) was undetectable in the samples. The authors conclude that “urbanization may play a role in increasing Hg exposure to these pollinators”, and honeybees could be a useful biomonitor for pollutants. The authors used seven NADP Mercury Deposition Network sites to associated mercury deposition to the concentrations in bees.

It is important to note that as of the last three months, we have started to build a new database system that will allow for searches of all of the publications that have used NADP data. This is complete for the 2022 year (https://nadp.slh.wisc.edu/pubs/bibliography_search/), and over the next several months we will collect and add the previous years starting in 2007, and will add the 2023 publications after the year’s end.

Of special note is the particularly important role that SAES and off-the-top funding plays in NADP. The SAES funding provides three very important advantages:

- (1) it enhances the ability of the SAES to address pressing needs of agriculture,
- (2) it controls NADP site loss due to lower costs for SAES participation, and
- (3) it leverages SAES funding by allowing participation of other federal and state agencies.

All NADP sites pay a management fee for operations. The SAES funding pays some of this fee for the SAES sites (evenly divided, essentially applying a “discount” to each site). The remaining costs are borne by the individual SAES. With a loss of NRSP status, the operational costs at all sites would increase significantly and many sites located in the agricultural production areas could potentially be shut down.

Implementation:

A. Objectives and Projected Outcomes: (4,000 characters)

Objectives

1. Characterize geographic patterns and temporal trends in chemical or biological atmospheric (wet and dry) deposition.
2. Support research activities related to: (a) the productivity of managed and natural ecosystems; (b) the chemistry of surface and ground waters, including estuaries; (c) critical loads in terrestrial and aquatic ecosystems; (d) the health and safety of the nation's food supply; and (e) source-receptor relationships
3. Support education and outreach through the development of informational materials and programs aimed at people of all ages.

Projected Outcomes

NADP provides timely deliverables of data free of charge. Stakeholders are encouraged to access data from the NADP website (<http://nadp.slh.wisc.edu/>). This site offers on-line retrieval of individual data points, seasonal and annual averages, trend plots, concentration and deposition maps, reports, manuals, educational brochures, and other information about NRSP-3. Quality-assured data and information from all networks are loaded quarterly into the on-line database system with a lag of ~180 days. Information available from this website and linked database management system constitute the deliverables that support the project objectives. NADP addresses special request data products, answers scientific questions, and assists users to find related information. Complementing the on-line data and information are publications such as annual data summaries, annual meeting proceedings and presentations, quality assurance documents (e.g., QMP), manuals, informational and educational brochures, and reports. All publications are available online (<http://nadp.slh.wisc.edu/lib>).

To assess the type and amount of research activity supported by NRSP-3, participants are asked to annually report their program activities and publications that use NADP data. Additionally, information is obtained from online literature repositories to locate all publications that reference or use NADP data, maps, and other information. These are summarized annual and provided on the NADP website (<http://nadp.slh.wisc.edu/lib/bibliography.aspx>), providing for a testable deliverable. More than ~95% of these publications are peer-reviewed journal articles and reports, and also includes masters and PhD theses and dissertations covering a vast range of research areas. The balance includes informational pieces, such as newspaper reports.

Over the last three total years (2020-2022), publications listed have numbered 217, 223, and 183 publications, respectively. This demonstrates that NRSP-3 is achieving the primary goals of NRSPs, namely, to support research (and NADP's Objective #2).

Program Improvements and advancements: Objective (1) was changed during the 2002-06 funding period to "chemical or biological atmospheric (wet and dry) deposition". This objective now explicitly mentions wet and dry deposition, including the (biological) deposition of plant pathogens and pollen. Current networks measure air concentrations of ammonia and mercury make possible the estimation of dry deposition fluxes and builds new research support capacity. Research activities under objective (2) were amended to address emerging interest in critical loads and the health and safety of the nation's food supply (mercury). During this period, a large part of the network changes have been towards monitoring for more N compounds (agricultural needs), and Black Carbon in precipitation (understanding trends and spatial distribution of pollutants from wildfires, relating NADP directly to climate) and PFAS compounds (discussed elsewhere). In summary, a focus of providing more data with the same activities/measurements increases the value of the network.

We feel that we have met all our goals for the current period and the previous year, and that all of our data was in place on time and used for research in many different agricultural areas. We can always make better use of our assets and will strive to continue to improve.

B. Management, Budget, and Business Plan: (16,000 characters)

Project Management and Business Plan: Project management of NRSP-3 is described in the *National Atmospheric Deposition Program Governance Handbook* (<https://nadp.slh.wisc.edu/pubs/brochures/>). This handbook defines the roles and responsibilities of the Executive Committee, the Program Office, and all committees and subcommittees. Each role is briefly summarized in the following sections.

The NADP Program Office (PO), located at the Wisconsin State Laboratory of Hygiene (WSLH) at the UW-Madison, is responsible for promoting long-term NADP operations that comply with the operational procedures and quality-assurance standards set by the Executive Committee (EC), with guidance from its subcommittees. The PO manages day-to-day network operations. The PO responsibilities include:

1. Securing site support, chemical analytical, and data validation services for NADP measurement programs.

2. Ensuring measurement programs produce consistent quality-assured data.
3. Managing the NADP databases and website.
4. Publishing annual map summaries, data reports and other miscellaneous documents.
5. Providing support for committee and subcommittee meetings.
6. Coordinating any special studies.

The NADP Coordinator is the PO Director and works in parallel with the principal investigator of the cooperative agreements between NADP sponsors and the UW-Madison. At least three times per year, the Coordinator reports to the EC on the status and progress of PO and NADP activities.

Budgeting is on a federal fiscal year basis. The Coordinator reports on the fiscal status of the project to the Budget Advisory Committee (BAC), which is responsible for financial planning. The BAC reviews the Coordinator's report and the Coordinator's income and expenditure plans for the upcoming fiscal year. The BAC makes its budget recommendations to the EC, which has budget approval authority. BAC membership consists of elected and ex-officio members and includes the USDA-NIFA representative. The WSLH develops an annual budget that is reviewed and approved by the WSLH Board of Directors, applying a high degree of oversight on the program. As part of the review, the NADP PO develops a balanced budget based on projected income and expenditures and a detailed cost analysis. This approved budget is then presented to the BAC. The budget is continually reviewed by PO and laboratory managers to ensure operations remain within the approved budget.

The Executive Committee (EC) is responsible for making policy decisions, budgetary decisions and ensuring program continuity and balance for NRSP-3. It provides technical and administrative guidance to the PO. The EC receives input and recommendations from the BAC on budgetary matters and the Quality Assurance Advisory Group on quality assurance matters. It receives input and recommendations from two standing technical subcommittees:

- The Network Operations Subcommittee (NOS), which oversees field-siting criteria and laboratory and sample collection protocols, and evaluates equipment and recordkeeping methods.
- The Education Outreach Subcommittee (EOS), which provides input on data user needs, and develops educational materials and programs or products to promote and increase participation.

The EC acts on recommendations and sets program policies and procedures. EC membership consists of four elected officers, the elected chairs of each of the technical subcommittee, the BAC co-chair, and a SAES representative, all of whom have voting privileges. Membership also includes ex-officio non-voting members, such as the SAES Regional Administrative Advisors, the NIFA program manager and the science committees. Membership in NADP is open and members may participate on any subcommittee or ad hoc group. Summaries of EC minutes, technical subcommittees, and science committees are provided on the web (<https://nadp.slh.wisc.edu/committees/>).

The EC continues to look for ways to engage new participation in its technical subcommittees, science committees, and annual meetings. In recent years, EC has added several science committees, who focus on scientific topics (critical loads (CLAD), total deposition (TDEP), mercury (MELD), aeroallergens (AMSC), urban monitoring (CitiDep)). Over the years, the focus has primarily been sulfur and nitrogen (see <https://nadp.slh.wisc.edu/committees/tdep/>), and is a good example of how more information (dry deposition estimates) of S and N, leverages for the benefit of agricultural researchers.

Linking multiple funding sources

The NRSP-3 project has had multiple sources of funding, since the beginning of its operation, and at least since the 1980s. Currently, the NRSP-3 is directly funded by approximately 100 agencies and groups, and funding is ~ \$3 million per year. Included in these agencies is the SAES (1.6% of total budget), seven federal agencies (~56%), approximately 30 state agencies (~35%), and miscellaneous universities, local, and tribal government agencies, environmental institutes, private companies and other research organizations (~5%). In FY23, there are 103 organizations that cooperatively fund the NRSP-3. All this money is leveraged from the original decision of the SAES station research idea, multiple long-term commitment of all organizations, and the designation of a national research support project. The key our success and longevity is truly the NRSP designation.

The base funding provided by the OTT MRF funding is extremely important to this project. Beyond the base funding for SAES stations (used to pay some of the management fees), this funding confers the national research support designation. This NRSP designation allows for direct support by the USDA-NIFA. NIFA then allows for federal and state agencies to cooperate with it in the project, which is the key to our multi-funder set up and long-term success.

There are no plans to change our multidisciplinary funding mechanism, and our commitment to allow all organizations to join with us in future funding.

Contributions by SAES

As mentioned previously, the SAESs operate, and have operated our longest operating monitoring stations with the NTN. Of our current 260 NTN sites, 54 of these are either sponsored or operated by SAESs, and located at land-grant universities (see a new interactive map here https://www.google.com/maps/d/u/0/viewer?mid=1-1YiEFtbqAjIg_Pqf_TS7jZ2vyyXPyU&ll=40.105997047819784%2C-83.33217015608807&z=5). These agricultural sites are located in all four SAES regions, with 41 of 54 sites having a 40+ year operating records.

Along with basic financial support, it is worth noting that these SAES sites provide operators and, in almost all cases, pay the salaries of these operators. They provide electricity and site locations, weekly maintenance of the samplers, mailing services, and management (there is an operator and a supervisor usually located at the SAES).

Agricultural research scientists use our data every year, and these research publications are specifically highlighted annually in our NRSP reporting with the SAES and USDA systems (NMIS and REEport). Additionally, the SAES Administrative Advisors have been long-term supporters and active members of the management of the program. Since about 2007, Dr. Buhler has been a very active member of our meetings (Spring, Budget, Fall). Dr. Payne has been active, particularly during our move (2017/2018) from the University of Illinois to the University of Wisconsin Madison. Drs. White and Xia are relatively new but have already started to participate (midterm review). Dr. G. Hopper/Mississippi State was a particularly good advisor, but he has since retired.

The long-term SAES Community Representative (Dr. Richard Grant/Purdue University) has been an active member of the NRSP-3 for many years, and has been present at almost all meetings and been an officer of the EC twice.

Additionally, we have the support of the SAES here at UW-Madison. I understand they were active and agreeable to the project move from the University of Illinois, supportive of our sites in the SAES system and state, and supportive of the administrative functions (financial) with the OTT funds. We have a good working relationship with the Soils and Forage Analysis Laboratory of the SAES system at UW Madison.

A summary for capacity and modest requested support for the NRSP-3, is as follows:

- NRSP-3 continues to support nationally important areas of research, addressing multiple Grand Challenges, and other areas of important research.
- Each year, numerous agricultural research journal articles are listed, as a specific and concrete example of the SAES mission for national research support projects.
- We provide a monitoring network useful to all agricultural regions, many SAES sites, and open to all agricultural research establishments.
- We have highly leveraged SAES funding (\$50,000) to \$3.0 million per year through its 100 direct support collaborators.
- We make basic measurements that can be used in a myriad of research areas and have a 40+ year record of consistent and valid monitoring.
- Given our active and widespread availability of people and monitoring ability, we have the capacity to grow to meet any current need or future unseen need, with proposals made by all agricultural scientists.

Project Budget: NRSP-3 provides the authority and framework for combining the resources of many diverse sponsors in support of NRSP-3. Project support is divided into monies administered by the UW-Madison Research and Sponsored Programs (RSP) and the monies and in-kind support for operating NADP site subscribers. Cooperative funds administered by RSP provide the resources for the PO to perform duties and obligations required to satisfy the six responsibilities listed above. Subscriber support site operations including cost of sample collection, transportation and electricity to run the site, sample shipping, and land access and office space. Support for site operations is not administered by WSLH but is provided through an agreement described in the “NADP Shared Services and Responsibilities” document.

Three funding streams provide support for the PO: (1) SAES off-the-top monies, (2) a cooperative agreement between the USDA-NIFA and UW-Madison RSP, and (3) agreements between individual SAES, universities, government agencies, or non-governmental organizations and the WSLH. The USDA-NIFA/ UW-Madison RSP cooperative agreement combines the support of six federal agencies (BLM, NOAA, NPS, USDA-Forest Service, USGS, and ARS), along with USDA, each having an interagency agreement with the USDA-NIFA. Each individual (type 3) agreement funds one or more sites.

Hatch funds provide off-the-top support and the land-grant university support of SAES sites. Since these funds can pay only direct program costs and under the NRSP-3 are combined with funds from other sources, all PO support, no matter the source, pays

only direct program costs. Indeed, the USDA-NIFA/UI cooperative agreement stipulates that monies be used only for direct costs and not for facilities and services. Total FY22 support from these three funding streams was \$2.91 million. From FY19 to FY24, off-the-top support remained constant at \$50,000. Therefore, over the years, SAES funds have been highly leveraged into an internationally successful NRSP.

NRSP-3 off-the-top monies provide partial support of the Program Coordinator. Since this position spearheads day-to-day outreach to new stakeholders and development of innovative data products that support new research interests, we propose a level NRSP-3 budget of \$50,000 per year for the FY24-FY28 renewal period.

The NRSP-3 funding model has enabled project growth and diversification of funding sources (see previous section). The NTN is currently at ~260 sites (very stable over the last 15 years). For the network to maintain its size and potentially grow the program, it must contain costs and gain efficiencies in network operations. All funding support leads to reduce per site fees, thus encouraging additional involvement in NADP. With the addition of the AMoN ammonia network, site numbers have increased rapidly to approximately 100 sites, including three sites operated by SAES scientists (AR, CO). Many of the sites are federal sites, with support from US EPA and the National Park Service, again showing leveraging of SAES support to other agencies with support SAES national priorities.

With the addition of the MDN (mercury deposition) in 1996, the number of individual (type 3) agreements has risen to current 85 sites. MDN support comes largely from state, local, and tribal government agencies in states confronting a growing number of health advisories because of mercury-contaminated fish. PO outreach efforts have been successful in enlisting new MDN support from these agencies. MDN is currently at 85 sites, most in the U.S., several in Canada (six sites), and within Tribal Nations (22 sites). This network effort supports the Grand Challenge 1, 4, and 5 (food sources, although not always agriculturally derived).

The NRSP-3 committees and PO continue to look for ways the project can serve regional and national needs. Partnering with USDA-ARS to use NADP samples for detecting ASR spores in precipitation was a very good use of the networks in the past. Initiating the AMON has demonstrated the viability of cost-efficient passive sampling methods for measuring ambient ammonia and is responding to the national need to better understand ammonia sources, atmospheric cycling, and deposition. This is a good agricultural use of the networks. This network shows a strong potential for future growth. Several other potential uses of the networks and agriculture have been identified in other section of this report.

These and other efforts remain true to the vision that NRSP-3/NADP will remain one of the nation's premier research support projects, serving science and education, and supporting informed decisions on air quality issues.

The requested project budgets and specific budget narrative are in the appendix of this report.

C. Integration and Documentation of Research Support: (5,000 characters)

Academic Programs: Data and information on the NADP website have become an important resource for educators at virtually every level. Users indicate that approaching 50% access on the site for educational purposes and the balance for research from academic institutions, with significant growth since the early 2000s (38% education). In 2017 (the most recent assessment, UI), total data downloads were identified as follows: 40% from federal and state agencies, 36% from universities, 16% from K-to-12 schools, and 6% from other individuals or organizations. We expect that these percentages are about the same, given their consistency over the years. These traditional tracking values have not been available at UW Madison. However, our new effort in the next 12 months (google analytics, mentioned previously) should give us a deeper insight into this type of tracking.

NADP data have been used for approximately 10-15 theses/dissertations each year. Over the last 10 years, authors have used NADP data, figures, and maps in undergraduate textbooks in biology, chemistry, environmental sciences, and related areas (54, 55). There are even used occasionally undergraduate honors theses (51). The NADP willingly supplies high quality graphics and data free of charge for these efforts. Secondary-level students continue to access on-line brochures, data and maps for use in science fair projects and classroom exercises.

NADP staff has been involved in extension work with Native American organizations concerning primarily mercury, motivated by the high tribal levels of fish consumption. NADP continues to contribute to the Institute of Tribal Environmental Professionals, National Tribal Air Association, and Tribal Air Monitoring Support Center. Additionally, over the last several years, NRSP-3 has worked within a project with U.S. EPA to further tribal monitoring within their own lands, including further NADP monitoring. Currently, the NRSP-3 cooperates with 22 separate Native American

tribes/sites who operate at least one network site in one network, while several run multiple networks.

Past and Ongoing Partnerships:

- The NADP partnership with the ARS Cereal Disease Laboratory at the University of Minnesota to quantify SBR in precipitation samples continued through 2011. This project was previously described in the National Relevance section.
- During 2010 to 2012, the NADP has adopted the PRISM (Parameter-elevation Regressions on Independent Slopes Model) method for developing deposition map products. PRISM data sets, based at Oregon State University, are recognized as being of very high-quality and are supported by the USDA Natural Resources Conservation Service, USDA Forest Service, and the NOAA Office of Global Programs.

Current Partnerships:

- The NRSP-3 collaborated with numerous external monitoring and research organizations including a partnership with the 2015 Acid Rain conference (New York State), and most recently with the 2022 Acid Rain conference, held in Niigata Japan. This meeting was in cooperation with the EANet Program (NRSP-3 like in Asia), and the Japan Ministry of Environment.
- The NRSP-3 is working directly on QA intercomparisons with the National Ecological Observatory Network (NEON) on improving mercury deposition measurements for both networks and comparability between the networks. NEON representatives have recently attended several NADP fall meetings.
- The AMON and AMNet were developed at the request of stakeholders to address the needs of the agricultural research community. In both cases, these newer networks have brought in new site and funding partners, and new researchers. AMON is of particular interest to SAES scientists (discussed elsewhere in this report).
- Cooperation with Mexico: The NRSP-3 is working directly with Dr. Rodolfo Sosa/National Autonomous University of Mexico (Mexico City), to help the Country of Mexico develop a similar NTN-like network for Mexico. The idea is currently at the proposal stage with much work left to do. But our goal is to help get the network operating on a status equivalent to NTN, making intercomparison of data directly possible. In the last two semesters, two graduate students have come to the U.S. to study our methods, which seem to have been valuable. More will be reported here in later annual reports.

- Other cooperative projects have been described earlier, including the new Aeroallergens subcommittee and cooperation with health professionals, the Total N and P sampling, working with the National Park Service, and SAES scientist Dr. J. Collett at Colorado State University, etc.

Support Nationwide Research: NADP data users are in every state and data is actively downloaded by international researchers. The NADP is in the majority of U.S. states and in Canada, Puerto Rico, and the Virgin Islands, and we collaborate with nations including Mexico, Japan, China, South Korea, and Taiwan. The AMON has 100 sites in 39 states and Canada (including all four SAES regions), with preliminary gaseous ammonia measurements extending back to 2007 and official network measurements beginning in 2010. The number of active data users and monitoring sites provide indications of the breadth of support and continued interest in NRSP-3, and recognition that NADP is responsive to emerging needs of researchers and policymakers. The breadth of reports and journal articles using or citing NADP data demonstrates the nationwide, indeed international, use of NADP data.

D. Outreach, Communications, and Assessment: (15,000 characters)

Outreach, Communications and Assessment

Audience: The NRSP-3 mission is to provide quality-assured data and information on atmospheric deposition for use by scientists, educators, students, policymakers, and the public. **The NRSP-3/NADP has effectively supported outreach and routinely assesses the impact of these activities through quantifiable metrics.**

The NADP website provides on-line access to virtually all project data and information, including educational and informational brochures. All data from all networks is freely available to all interested users through the website (<https://nadp.slh.wisc.edu/>). This includes the 500,000+ samples for precipitation chemistry and wet deposition collected thus far over all regions of the U.S. and now Canada.

Download web statistics have been presented previously. User statistics show the continual growth in the number of registered users and data downloads, two indicators of the importance and relevance of the data.

In its role of assessing project performance, the NRSP-3 Executive Committee charged the PO with updating the website to improve the organizational layout, facilitate data and map accessibility, enhance communications, and modernize the “look and feel”.

NADP has received beneficial feedback through its EOS as to best structure the materials to meet the needs of stakeholders. The second webpage update was completed in early 2023 and available. The website includes sections featuring:

- Education, with new materials for classrooms at the 4th to 6th grade and senior high level.
- News section, where NADP can highlight new happenings with the network, and all current subjects get added to the website quickly.
- Committees section, where mission statements and topics of discussion, minutes, and related materials are located.
- Publications section, including all NADP standard operating procedures, minutes, and presentations from meetings, etc.).
- Operators section, which is new in the last year is a section specifically for all site operators, including standard operating procedures, tools for uploading field data, training videos (new to the project), and a section for starting new sites.

Engagement of Stakeholders: Stakeholders are involved in committee and subcommittee activities, and twice yearly meetings as previously described. In addition, members participate in triennial laboratory and quality management reviews, where they provide recommendations for improvement. Committees and subcommittees identify emerging scientific needs and interests, where all stakeholders are welcome. For example, the AMoN, AMNet, and the new Aeroallergens subcommittees originated with committee discussions. As mentioned in “Management, Budget, and Business Plan,” the committees continually seek increase participation from land-grant university scientists, especially at annual technical meetings.

NADP actively supports engagement with stakeholders, for example at the 2019 Fall Science Symposium and Meeting, NADP through direction of its federal partners is hosted a NADP TDep Workshop "Connecting Stakeholder and Science Perspectives to Better Understand the Linkages Between Agriculture and Reactive Nitrogen Deposition". These special meeting workshops have been held in the past, including one recently on agricultural ammonium. For Spring 2024 (April 29), the TDEP subcommittee is planning for a workshop. Details will be available online with the meeting schedule.

Measuring Accomplishments: Methods to measure program outputs, accomplishments, and impacts have been described in previous sections of the proposal and include:

1. An annual request to all program participants to send a list of accomplishments and publications utilizing NADP data to the PO.

2. Routine searches of scholarly repositories, journal articles, and professional reports.
3. Compilations of web user statistics.
4. Identification of NADP data use in policy-related documents and websites, e.g., NAPAP reports, NRC reviews, government agency reports and websites.
5. Participation in NADP meetings.
6. Routine program reviews.

Many of these have been discussed in other parts of this proposal.

Communication Pieces: The NADP's principal data product is its annual map summary report, which provides a summary of annual highlights and map products. This summary is distributed at scientific meetings and is mailed to all program participants. This year (2023), a new feature is a digital document meant to be read online in a "reading format" (see <https://heyzine.com/flip-book/796fbdb6dc.html>). This is designed to make it more available to younger scientists who, effectively use electronic documents. Additional publications are available on the NADP website and in print form:

1. *Welcome to NADP*, which describes the program to "newcomers", encourages their involvement, and is regularly updated with upcoming meeting dates.
2. *Nitrogen From the Atmosphere*, which is a redesign and rewrite of *Nitrogen in the Nation's Rain* (early 2000s document), with a focus on the gaseous constituents, how nitrogen actually gets into precipitation, and an additional focus on dry deposition of nitrogen along with wet deposition;
3. *Critical Loads: Evaluating the Effects of Airborne Pollutants on Terrestrial and Aquatic Ecosystems*, where this brochure outlines the function of NADP's Critical Loads Scientific Subcommittee, outlining their products (mapping of critical loads for forests primarily for N, etc.);
4. An updated *Ammonia Monitoring Network (AMoN) Fact Sheet*, which describes issues related to gaseous ammonia, and provides an overview of methods and measurements in the AMoN; and
5. *NADP's Governance Handbook*, providing the structure and operation of NADP's officers, committees, and organization (continually updated), providing a primer for stakeholders, students, and new scientists of the structure and operation of NADP (provided at meetings). This document is updated regularly.

Distribution of Results: As described in previous sections of this proposal, NADP data are distributed primarily via the NADP website, which offers easy-to-use on-line

retrieval of data in multiple formats. During 2022, NADP estimated ~20,000 comma-delineated data sets were downloaded, including 14,000 from the NTN database.

In addition, during the next 12 months, with support from UW-Madison computing, NADP would like to add Google Analytics (or similar) to our website. This software is sold as marketing software, but we will use it to give a much deeper insight into who is visiting our website, provide a better understanding of what users are looking for, and very specific counts of what webpages are being read, what is being downloaded, etc. This type of information is very valuable in reporting (as with this report), and for the Education Subcommittee (EOS) to fulfill its goals.

Every year, a scientific symposium is held where presenters summarize the results of their scientific studies that use NADP data. The FY17 through FY23 Fall Scientific Meetings were held in San Diego CA, Boulder, CO, Knoxville TN, , and Madison WI, and online during the COVID-19 pandemic. A typical Fall Symposium has approximately 150 attendees, and 20-30 students. Since we are an NRSP, it is important to the committees to move the meeting around the country so that new attendees and students living near the meeting will be more likely to attend. All our meetings, with attendees' listings and presentations, can be found here (<https://nadp.slh.wisc.edu/conferences/>).

Even though COVID-19 presented many difficulties and challenges, it did teach us the advantages of holding online meetings efficiently and developing training that could be accessed anytime. The technical challenges of combining both live and online presenters, making sure everyone could ask questions and be heard, etc. But, we have now learned how to hold these meetings relatively well, and we will continue to hold hybrid meetings. Especially important here is the number of non-North American attendees that were present (China, Japan, Taiwan, Mexico, Peru, various European countries, Canada).

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Appendix F: Budget

Project Title: NRSP003 - The National Atmospheric Deposition Program (NADP)

Requested Duration: October 1, 2024 to September 30, 2028 (FY25-FY29)

Budget & Narrative

In support of the NRSP-3 application, we present the following budget and narrative description.

The MRF funding will be used for salary support for one person at the Program Office of the National Atmospheric Deposition Program. This support for the Program Coordinator will go towards the management of the project, and support the positions most responsible for carrying out the outreach and communication mission of the NRSP. This funding will provide approximately one-half of the salary and benefits for this employee. The FY24 salary figure represents salary for the Program Coordinator, based on current FY23 salary. Other non-salary funding is not being requested.

The "Other Sources" table also contains a few assumptions and requires further explanation. These values include all funding categories listed (industry, federal agencies, grants/contracts, and SAESs). Therefore, this table represents the total project budget plus the SAES funding (approximately 1.6% of the total budget). This budget begins with the approved 2020 budget value. With these assumptions, annual values are estimated for the next five funding years.

Additional categories were added to this table to demonstrate itemized costs important to this project. The total wages (fringe plus salary) are reported as the sum of the Salary and Fringe lines. The total FTE represent all projected PO and laboratory personnel required to successfully operate the program. Supplies and services include all contractual services and the supplies for PO and laboratories including printing and laboratory supplies to operate during the project period. Maintenance and repair includes equipment upkeep (maintenance contracts and repairs), depreciation on equipment, building changes and upkeep and the like. Communication include the cost of office communication including operation of the site liaison 800 number, and some printing. Travel and training includes costs associated with the spring and fall meetings as well as cost for outreach such as at national conferences. Rent and overhead cover the small cost of building rent, and overhead associated with WSLH support including NADP subscriber billing (financial), purchasing services, human resources services, and information technology services (computing, web).

NRSP-3, The National Atmospheric Deposition Program (NADP) - A Long-term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition										
DESCRIPTION	Proposed FY25		Proposed FY26		Proposed FY27		Proposed FY28		Proposed FY29	
	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE
Salaries	37,600	0.6	37,600	0.6	37,600	0.6	37,600	0.6	37,600	0.6
Fringe Benefits	12,400		12,400		12,400		12,400		12,400	
Total Wages (Salary and Fringe)	50,000		50,000		50,000		50,000		50,000	
Supplies & Services	0		0		0		0		0	
Maint. & Repairs	0		0		0		0		0	
Communication	0		0		0		0		0	
Travel & Training	0		0		0		0		0	
Rent & Capital Equip. Dep.										
TOTAL	50,000	0.6	50,000	0.6	50,000	0.6	50,000	0.6	50,000	0.6
OTHER SOURCES OF FUNDING										
Other: EPA, USGS, ARS, USFS, US Park Service, BLM, NOAA, States, Tribes, Canada, Industry, NGOs, etc.										
DESCRIPTION	Proposed FY25		Proposed FY26		Proposed FY27		Proposed FY28		Proposed FY29	
	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE	Dollars	FTE
Salaries	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3
Fringe Benefits	486,000		486,000		486,000		486,000		486,000	
Total Wages (Salary and Fringe)	1,886,000		1,886,000		1,886,000		1,886,000		1,886,000	
Supplies & Services	426,000		426,000		426,000		426,000		426,000	
Maint. & Repairs	322,000		322,000		322,000		322,000		322,000	
Communication	5,000		5,000		5,000		5,000		5,000	
Travel & Training	47,000		47,000		47,000		47,000		47,000	
Rent, Overhead & Capital Equip. Dep.	173,000		173,000		173,000		173,000		173,000	
TOTAL	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3