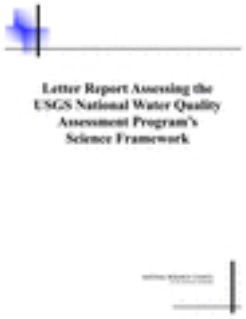

Letter Report Assessing the USGS National Water Quality Assessment Program's Science Framework

Committee on Preparing for the Third Decade (Cycle 3) of the National Water Quality Assessment (NAWQA) Program; National Research Council

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Letter Report Assessing the USGS National Water Quality Assessment Program's Science Framework

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of the National Water Quality Assessment (NAWQA) Program

Water Science and Technology Board

Division on Earth and Life Studies

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Dear Dr. Rowe:

In 2009, the U.S. Geological Survey requested that the National Research Council's (NRC) Water Science and Technology Board review and provide guidance on the direction and priorities of the National Water Quality Assessment (NAWQA) Program. This review would include perspective on past accomplishments and the current and future design and scope of the program as it moves into its third decade of water quality assessment (Cycle 3). In response, the NRC formed the Committee to Review the USGS National Water Quality Assessment (NAWQA) Program in order to address a set of tasks agreed upon by the USGS and NRC (see Attachment B, roster; see Attachment C, Statement of Task).

Once the study was underway, the USGS NAWQA Cycle 3 Planning Team asked the committee to give priority to its first task (see Attachment C) concerning the scientific priorities of the NAWQA program as expressed in its NAWQA Science Framework[1]. The committee was asked to provide an assessment of the Science Framework in terms of whether it sets forth adequately the priorities for the future which will be addressed in the third cycle of the NAWQA program. This letter report provides the committee's response to this request or "guidance on the nature and priorities of current and future water quality issues that will confront the Nation over the next 10-15 years" (see Attachment C, item #1). The committee's final report, anticipated in the spring of 2011, will address the remainder of the first task and the entirety of the statement of task.

The purpose of the Science Framework, the first of two documents on the Cycle 3 design, is "…to outline and describe a framework of water quality issues and priorities for Cycle 3 that reflect the unique capabilities and long term goals of NAWQA, an updated assessment of stakeholder priorities, and an emphasis on identifying potential approaches and partners." It begins with a discussion of NAWQA's unique role in assessing current and future water quality

[1] Available online at: http://pubs.usgs.gov/of/2009/1296. The Science Framework is a working document and is the basis for the NAWQA Cycle 3 program.

issues, followed by background on approaches and issues, and concludes with a statement of priority issues facing the nation in the coming years.

NAWQA divided priority issues for Cycle 3 into two categories: 1. Stakeholder Issues Related to Major Environmental *Drivers*, and 2. Stakeholder Issues related to Water Quality *Stressors*. Eleven topical priorities were itemized within the two categories (five drivers, six stressors). Under each priority issue, NAWQA described the nature and scope of the issues articulated by various stakeholders, the program's role and approaches to address the designated issues, and partnerships and collaborative opportunities related to each issue.

Although the Science Framework is a logical and well written document containing an extensive list of water quality issues facing the nation, there remains opportunity for focus and greater clarity. We offer the following suggestions to refocus and reframe the Science Framework. Our intent is to highlight the already achieved and potential scientific impact of the NAWQA program which is critical to future success of NAWQA as it moves into and through Cycle 3. NAWQA is a successful program (NRC 2002, 2009) as it stands and our suggestions are to further improve and help protect what the program already has achieved.

Vision and Principles for NAWQA

From the beginning, a premise of the NAWQA program was a water quality program with *national* impact and coverage. NAWQA's commitment to national level work should be prefaced by a vision for water quality at the national scale. A national water quality program should include national scale surveillance, scenario development, and forecasting. (Scenario development considers how changing land use conditions and climate, for example, may affect water quality in different settings.) It should characterize and evaluate the quality of the nation's waters and serve as a tool for water policy and decision makers in their evaluations of the nation's water resources and their establishment of policies in areas that consider water quality. To this end, the Science Framework, as presented, moves in this direction but needs to be *far more explicit* than implicit in its exposition. The committee recommends that NAWQA better articulate its vision first and foremost in the document and then explicitly describe the value of the program to the nation's water policy and decision makers.

Immediately after presentation of a well articulated vision, NAWQA should outline clarified program principles that are "front loaded" in the planning document. Program principles orient the NAWQA program within the USGS and the federal government. Perhaps most importantly, program principles serve as an internal assessment and guide to keep the program focused and on target. In the following, we highlight program principles and encourage NAWQA to continue this endeavor, making these words their own. We begin with suggesting that the first two program principles address the following points:

- Clearly define and adhere to what *national* means to NAWQA—perhaps to lay down a marker as to where the programmatic tipping point may be from a truly national program to one that lacks adequate spatial coverage and representativeness of conditions to be counted as such. This marker should incorporate consideration of the impacts of abandonment of Study

Units to date, as well as the future of the Study Unit paradigm. NAWQA ought to address the trade offs between benefits from what they plan to "study" and the data given up from the loss of Study Units.

- Identify areas where NAWQA can make a contribution (both social and economic) drawn from research questions and findings that policymakers could expect with respect to water quality.

The committee notes that the Science Framework identifies program principles in Chapter four to guide NAWQA efforts (see Chapter 4: Guiding Principles, Funding Scenarios, and Next Steps for Planning Cycle 3). We support these principles, suggest they follow the two principles mentioned above i.e., are "front loaded" in the document, and recommend a slight expansion in scope (identified below by italics):

- Defining NAWQA's role, or scientific *areas where NAWQA can make unique and substantial contributions such as monitoring for nutrients or sediment,* in water quality assessment,
- Develop NAWQA priorities to be consistent with the six recently designated USGS Strategic Science Directions,
- Maintain continuity of long term goals and design of the program, *i.e., status, trends, and understanding.*

Water Quality Drivers and Stressors

The USGS is commonly viewed as an independent, unbiased, non regulatory driven and high quality source of data and its interpretation. Indeed, the USGS Water Resource Discipline was encouraged by the NRC Committee on USGS Water Resources Research to "lead the nation in water science" (NRC, 2009). NAWQA has the ability to illuminate and address national water quality issues and we encourage the program to do this, within its purview. Moreover, with a national scope NAWQA is well placed to address big picture drivers or causes of change and issues related to water quality that the nation faces. Translating this to the Science Framework, we recommend NAWQA reframe the planning document around big picture drivers.

We do not find the major environmental drivers and water quality stressors itemized in the Science Framework mutually exclusive. The terms "driver" and "stressor" are linked. We consider drivers regional or national scale anthropogenic and natural forces that directly or indirectly cause stress, or changes, to water supplies and associated ecosystems at multiple scales. For example, one *driver* would be climate change, which causes *stressors* such as increased storm intensity. In other words stressors constitute technical topics, or "priorities" that should be structured within the context of the drivers, or "causes", for changing water quality and key policy relevant questions that NAWQA hopes to answer.

Specifically, we recommend that NAWQA reorganize its activities to focus on the two major large scale drivers affecting national water quality: (1) change in land use due to population and other demographic changes; and (2) climate variability and change, which were mentioned in the USGS Science Framework, although not in this context. As such, these drivers

are clearly important to both NAWQA and its stakeholders. The committee and others (NRC, 2009) agree with this importance and note that a large majority, if not all, of the stressors on aquatic systems and changing water quality link directly to a changing climate and changing land use practices. These large scale drivers provide a fully adequate umbrella under which most environmental challenges and, ultimately, the NAWQA priorities can be identified.

We define land use change due to population and other demographic changes as change in the use of land for cities, for agriculture (including changes in crop type), for forestry, etc. due to multidimensional changes in numbers of people, their geographical distribution, the age distribution, and other changes over time. Such changes generate an evolving alteration of the landscape and impacts on water quality. For example, large-scale agricultural practices changed the landscape in the Midwest such that it now stresses the Mississippi River system and Gulf of Mexico with excessive nutrient runoff and sediment influx from erosion. The same stressors are also the result of expanded transportation networks based on cars and increased impervious surfaces as land use changes from urban to suburban or exurban areas.

Climate variability and change drives many stressors related to water quality. This includes altering the balance within the hydrologic cycle, which impacts infiltration and recharge to watersheds, aquifers, and river base flows, precipitation frequency and intensity, flooding and storm surge, and water storage in snowpacks. For example, in the Western U.S., mountain snowpack is diminishing and melting earlier than in the past although the total volume of precipitation is not changing significantly. This is 1) increasing late winter and early spring runoff and 2) reducing spring and summer runoff. The latter will impact water quality by producing higher stream temperatures and concomitant lower dissolved oxygen levels along with less water for waste dilution, whereas the former may increase flooding with associated increases in sediment and contaminant loads (Service, 2004). Also, higher water temperatures earlier in the season combined with nutrient wash off in early spring through melt or rain will likely lead to increased algal blooms and eutrophication frequency.

In the face of (water resource) challenges caused by climate and land change, policy "Decisions will be made, with or without scientific input." (NRC, 2009), and logically using science best meets the needs of society. To that end, NAWQA managers and scientists need to think about which components of these two major drivers they best can tackle. The other nine "drivers" and "stressors" in the Science Framework are subtopics that can be addressed under these major items.

The committee recommends NAWQA explicitly lay out *policy relevant research questions* under the auspices of each driver. These research questions will convey to decision makers and water managers the important topics that the NAWQA program will address as well as the critical value of the NAWQA program itself. An example of a policy relevant question might be: How would changing land use and a changing climate affect water quality, quantity, and allocation in the American west? Or, how will changing climate and land use affect the balance of human water needs and valued ecosystem needs in different regions of the United States?

To do as we suggest, NAWQA leadership should first determine how it can use the program and other historic data and the USGS forecasting and scenario development abilities to answer policy relevant research questions that demonstrate program impact. The answers to this determination will help rank program priorities that consider the two major water quality drivers, change in land use due to population and demographic change and climate change, facing the nation. As an example, consider how Midwestern agriculture has led to hypoxia in the Gulf of Mexico. The driver in this case is *change in the intensity of agricultural land use due to cropping practices, in part, related to population and demographics,* and the stressors are *sediment* and *dissolved nutrients*. The policy relevant research question is addressing how *future change in agricultural practices would aid in remediation of Gulf Coast hypoxia?* and the impact is a contribution to one of the most challenging water quality issues facing the nation.

A Case for Clarity

We cannot emphasize enough that NAWQA should be clearer with respect to its purpose. The committee finds refocusing and reframing of the document to be the first step to clarity. This will elucidate exactly which program priorities from the Science Framework will best serve a nation facing significant water quality challenges related to changing land use and a changing climate. Taking this a step further, NAWQA should define the *scale* of endeavors, articulate *specific examples* of activities, and define key terms (e.g. "water quality", "ecosystem health", "microbial contaminants") within each priority.

The lack of attention to scale in the Science Framework was surprising. Scale is *a* if not *the* key component that makes NAWQA a unique program. Again, a national water quality program should include *national scale* surveillance, scenario development, and forecasting. It should characterize the quality of the nation's waters and serve as a tool for water policy and decision makers in their evaluations of the nation's water resources. Scale constitutes a unique niche for NAWQA, compared to science done by other federal agencies. Many components of water problems are local to regional in nature. Yet scale issues emerge naturally as the interaction between land use change due to population and other demographic changes, and climate change is considered for different water quality attributes. NAWQA has successfully linked the regional and local variations into national synthesis of water quality assessments. NAWQA should continue to consider how processes in regional studies are linked on a national scale. Furthermore, as the program moves into Cycle 3, scale should be considered on each level of the planning document from the articulation of the program vision to its role in regional and topical studies as well as the sampling and modeling design for both assessment and prediction.

The generic approach to the partnership sections was uninformative; NAWQA should be more explicit in its plan to execute collaboration. We define collaboration as working together, publishing together, and leveraging resources or science capabilities (data, human resources, modeling capacity, etc.). Appropriate clarification would include specific examples of current and future collaborative partners, programs both inside and outside the U.S. (e.g., various EPA programs, relevant Canadian and Mexican activities, and NSF's planned NEON, STREON, and WATERS), and activities with particular attention to how NAWQA fits with the new USGS Water Census initiative as well as how water resources are connected to other countries.

In the spirit of achieving clarity, we provide specific comments on each of the Science Framework's eleven priorities in the context of our suggested reframing of the document. Our criteria for these comments are that NAWQA should focus on national issues, should combine priority areas when possible, and should concentrate on areas where NAWQA can make unique and substantial contribution.

First and foremost, Policies, Regulations, and Management Practices and Effects of Multiple Stressors are cross cutting topics that should be considered and integrated into all programmatic activities. They are design principles, not priorities, that are unevenly plugged in across the document. Rather, all priorities should be defined in terms of policy needs with consideration of multiple stressors. For example, what does a national synthesis report on topic "X" mean with respect to policy relevant topics currently being considered? What are the big picture questions answered by such a synthesis that capture the implications of multiple stressors on water quality?

Addressing Common Chemical Contaminants is NAWQA's "bread and butter", and obviously should remain a core priority. NAWQA should carefully consider Microbial Contaminants within the scope of a national vision. It is nonetheless critical that NAWQA articulate policy relevant research questions that connect these contaminant issues to climate change and land use change and population growth in order to clarify NAWQA's approach and show the relevance of its work within these priority areas. Terms such as "limit human use" or "affect aquatic ecosystem health" appear frequently and require definition and clarification. How can these terms be assessed using field measurements? Particular attention should be paid to how NAWQA coordinates and collaborates with EPA in the context of drinking water.

The committee supports NAWQA continuing its work on eutrophication. Yet eutrophication, as a priority, seems no different than understanding the results of monitoring of nutrients and/or other parameters such as chlorophyll a. Understanding the process of eutrophication is an outcome of NAWQA's monitoring for Common Chemical and Microbial Contaminants. Therefore, we recommend eutrophication be subsumed as a component of Common Chemical and Microbial Contaminants and related to the two major drivers—as the drivers are "source terms" affecting nutrient loading that result in eutrophication. It should be clear that NAWQA's work on eutrophication falls within the scale of major river and estuarine environments when considering nutrient related policy questions. It is important to define NAWQA's partnership role thoroughly here, particularly with entities outside the agency (e.g., with NOAA and EPA).

Sediment is a critical issue that NAWQA is well positioned to address. How the sediment delivered in response to changing land use influences aquatic ecosystems and how sediment may be controlled within dam management and operations while minimizing ecological and economic impact constitute examples of policy relevant issues. Detailed sediment flux and discharge monitoring is very costly and may be beyond NAWQA's means, but NAWQA has the capacity to address sediment in the context of key questions aimed at addressing major ecosystem and economic impacts using SPARROW modeling (SPAtially Referenced Regressions On Watershed attributes) as a central tool. NAWQA should bring to

bear its hydrologic and geologic expertise on this issue to complement and enhance the engineering perspective driven by other federal agencies.

Wastewater Reuse does not appear within the NAWQA purview because of scale and should be omitted as a high priority. While there are clear water quality issues related to reuse, most projects are local in nature and would not be well suited for integration with the larger national priorities that NAWQA should address. (Concrete examples of how the NAWQA program addresses this issue on a national scale would be necessary prior to further pursuit.) Wastewater Reuse would seem a topic that the new USGS Water Census initiative might tackle. NAWQA certainly needs to stay abreast of Water Census developments, and perhaps work collaboratively with the Water Census.

Hydrologic Modification and Flow Modification should be merged and considered in tandem. By adopting this approach, NAWQA planning would unify all activities probing flow and hydrologic modification, including drinking water. Policy relevant questions within this priority could overlap with Sediment, i.e., questions regarding flow modification and sediment flux. Clarification of priority scope is necessary to distinguish between Sediment and Hydrologic Modification and Flow Modification.

NAWQA should play a careful role with respect to Emerging Contaminants to avoid getting caught up in the "contaminant of the day." First, NAWQA needs to clearly define the scientific concerns with respect to this issue; why should certain emerging contaminants or contaminant classes be monitored? As part of this effort, NAWQA needs to clearly address how it defines "emerging contaminants". The term represents a huge continuum of compounds that makes a "one size fits all" approach inappropriate and, frankly, intractable. If scientific concern is deemed adequate, NAWQA should move into contaminant areas for which there are clear, established methods and approaches or in which it can do meaningful surveillance. We suggest NAWQA begin with only special projects on emerging contaminants or those driven by clear scientific concern and thus, policy considerations. Careful attention should be paid to coordination with the USGS Toxics Program whose mission is to conduct field based research to understand behavior of toxic substances in the nation's hydrologic environments in support of the development of strategies to clean up and protect water quality.

NAWQA can address only some portions of Energy and Natural Resource Development priority. Some issues within this priority are too localized for NAWQA to address. NAWQA leadership should think through what they can do well in this arena and the resulting strategy might be segmented. For example, the NRC, in its Cycle 2 NRC report (NRC, 2002), suggested that NAWQA leadership should evaluate clearly whether it actually had the resources to comprehensively address water quality degradation related to mining. NAWQA is best positioned in Energy and Natural Resources Development with respect to biofuel development which can be addressed under both drivers. The committee commends and encourages this work. However, NAWQA does not seem well positioned for evaluating water degradation caused by energy development overall. The committee does not advise NAWQA to take the lead on this issue among the agencies that deal with water resources or within the USGS.

Summary

The Science Framework is an opportunity to demonstrate the past, present, and future impacts of NAWQA and to articulate a compelling case for the need for NAWQA—a need in which the committee strongly believes. NAWQA is a unique program within a unique agency filling the niche of producing high quality national water quality data and interpretation; it is unequaled by any other entity. The committee urges creation of a more focused, restructured, and clarified planning document for Cycle 3 of the NAWQA program. It should clearly and compellingly demonstrate how the program has had and will have an impact on national water policy, and, in part, secure that NAWQA moves through Cycle 3 intact as our nation's premier water quality monitoring program.

Sincerely,

Donald I. Siegel, *Chair*
Committee to Review the USGS
National Water Quality Assessment
(NAWQA) Program

Attachment A: References
Attachment B: Committee Membership
Attachment C: Statement of Task
Attachment D: Acknowledgement of Reviewers

cc:
Matthew Larsen
Donna Myers

ATTACHMENT A

REFERENCES

National Research Council (NRC). 2002. Opportunities to Improve the U.S. Geological Survey National Water Quality Assessment Program. Washington, D.C.: National Academies Press.

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ATTACHMENT B

COMMITTEE ON PREPARING FOR THE THIRD DECADE (CYCLE 3) OF THE NATIONAL WATER QUALITY ASSESSMENT PROGRAM

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ATTACHMENT C

STATEMENT OF TASK

The project will provide guidance to the U.S Geological Survey on the design and scope of the NAWQA program as it enters its third decade of water quality assessments. T he committee will assess accomplishments of the NAWQA program since its inception in 1991 by engaging in discussions with the Cycle 3 Planning Team, program scientists and managers, and external stakeholders and users of NAWQA data and scientific information. The committee will also review USGS internal reports on NAWQA's current design for monitoring, assessments, research, and relevance to key water topics. The main activities of the study committee will be to:

1. Provide guidance on the nature and priorities of current and future water quality issues that will confront the Nation over the next 10-15 years and address the following questions:
   - Which issues are currently being addressed by NAWQA and how might the present design and associated assessments for addressing these issues be improved?
   - Are there issues not currently being substantially addressed by NAWQA that should be considered for addition to the scope of NAWQA?

2. Provide advice on how NAWQA should approach these issues in Cycle 3 with respect to the following questions:
   - What components of the Program—Surface Water Status and Trends; Ground-Water Status and Trends; Topical Understanding Studies; National Synthesis— should be retained or enhanced to better address national water quality issues?
   - What components of the program should change to improve how priority issues are addressed?
   - Are there new Program components that should be added to NAWQA to enable the Program to better address and analyze National water quality issues and related public policy issues?

3. Identify and assess opportunities for the NAWQA Program to better collaborate with other Federal, State, and local government, non-governmental organizations, private industry, and academic stakeholders to assess the nation's current and emerging water quality issues.

4. Review strategic science and implementation plans for Cycle 3 for technical soundness and ability to meet stated objectives.

ATTACHMENT D

ACKNOWLEDGMENT OF REVIEWERS

This letter report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We wish to thank the following individuals for their review of this report: Kenneth R. Bradbury, University of Wisconsin and the Wisconsin Geological and Natural History Survey; Joan G. Ehrenfeld, Rutgers University; Mike Kavanaugh, Malcolm Pirnie, Inc.; Kenneth H. Reckhow, Duke University; and Marylynn Yates, University of California, Riverside.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Henry J. Vaux, Jr., University of California, Berkeley. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.