DRAFT FIVE YEAR SCIENCE PLAN FOR THE

NATIONAL WATER-QUALITY ASSESSMENT PROGRAM, 2008-2012

September 2007

Executive Summary

The purpose of the Five Year Science Plan is to define key scientific directions, technical support, and outreach activities of the National Water-Quality (NAWQA) Program over the next five years (2008-2012). The document is organized by five major program elements that cover three general types of activities, and encompass a large breadth of scientific investigations. Additional NAWQA activities described in this Five-Year Plan include technical support activities that focus on process understanding, methods development, and modeling; and outreach activities that focus on partnerships, liaisons, and communication strategies. Specific objectives, budget, and expected outcomes and products for each of the Program elements are presented. In total, these five Program elements are funded at about $63 million each year.

In 1991, the U.S. Congress established NAWQA to develop long-term, nationally consistent information on the quality of the Nation's streams and ground water, and thereby support scientifically sound decisions for water-quality management, regulation, and policy decisions. NAWQA objectives are to provide an understanding of (1) the status of water-quality conditions; (2) how conditions are changing over time (trends); and (3) how natural factors and human activities affect water quality.

During its first cycle, from 1991-2001, the NAWQA Program conducted interdisciplinary assessments and established a baseline understanding of water-quality conditions in 51 of the Nation's river basins and aquifers (referred to as Study Units), which covered parts or all of nearly 50 states. Since 1991, significant progress has been made towards the Program's first objective to assess status, resulting in extensive descriptions of specific aspects of water-quality conditions in streams and ground water in more than a thousand reports (http://water.usgs.gov/nawqa). Water-quality conditions were assessed in relation to human activities, land use, and natural factors that can affect water quality and ecological health in the Nation's diverse geographic and environmental settings. In addition, observed conditions were compared to national water-quality standards, guidelines, and benchmarks to assess the potential effects of water-quality conditions on human health and aquatic life.

Studies during the Program's second cycle (2001-2012) cover 42 of the 51 Study Units. Since 2001, NAWQA has progressed towards its second and third objectives to assess long-term trends and to understand how natural processes and human activities affect the quality of streams and ground water. These two objectives also remain primary over the next five years as part of the Program's three general types of scientific investigations:

- *Continued national-synthesis assessments* on nutrients, aquatic ecology, trace elements, pesticides, and, to a lesser extent, VOCs.
- *Regional and national assessments of status and trends.* These assessments focus on surface-water-quality in the 42 Study Units grouped within 8 major river basins in the U.S.; ground-water-quality in about one-third of the Nation's 62 principal aquifers; and source-water-quality in drinking-water supply wells, stream intakes, and in finished water associated with about 50 large community water systems.
- *Topical studies of national water-quality priorities* that focus on understanding: (1) the fate and transport of agricultural chemicals, (2) effects of urbanization on stream ecosystems, (3) effects of nutrient enrichment on stream ecosystems, (4) bioaccumulation

of mercury in stream ecosystems, and (5) transport of contaminants to public-supply wells.

The development and application of models is integral to the NAWQA scientific investigations over the next five years to help to extend water-quality understanding to unmonitored areas, including major river basins and principal aquifers beyond the boundaries of the 42 Study Units. Also integral to the NAWQA activities is increased integration of data collected through other USGS programs, and that build on partnerships other governmental agencies (Federal, State, regional, and local), nongovernmental organizations, industry, and academia.

The NAWQA Program will continue to emphasize outreach activities and extensive collaboration with government, research, and interest-group partners to ensure relevance of findings to local, State, regional, and national water-resource issues. Findings to date have added significantly to the unbiased basis for decision makers (http://water.usgs.gov/nawqa/xrel.pdf), and will continue to help address a wide range of water-quality issues, particularly those related to water conditions and trends and potential effects on source and drinking water, human health, and aquatic ecosystems. NAWQA information is directly relevant and supportive of the USGS 10-year Science Strategy, particularly relating to understanding ecosystem change, contribute to an understanding of the role of the environment in human health, and securing available freshwater for America's future. Links between NAWQA's scientific understanding and decision making is accomplished through implementation of the Program's external multi-tiered communication process, liaison activities, and partnerships at local, State, regional, and national scales.

In addition, NAWQA will continue its commitment to high-quality products that are responsive to broad stakeholder needs. The Program anticipates the continued production and dissemination of technical and non-technical publications, including comprehensive summary and synthesis reports (USGS Circulars) on the occurrence of nutrients in streams and ground water and aquatic ecological conditions in streams across the Nation. Additional products and outcomes include an expanded NAWQA data-warehouse; models and application software; readily accessible information—including data, reports, maps, support tools, and methods—on the NAWQA website; updated bibliographies and search engines; and, continued participation in scientific and water-related conferences and workshops at all levels of the Program.

II. Introduction

In 1991, the U.S. Congress established the National Water-Quality Assessment (NAWQA) Program to develop long-term, nationally consistent information on the quality of the Nation's streams and ground water in order to support scientifically sound management, regulatory, and policy decisions. Findings to date have added significantly to the unbiased scientific basis for decisions makers, managers, and planners at all levels of government to cost-effectively address a wide range of water-quality issues related to natural and human influences on the quality of water and potential effects on aquatic ecosystems and human health (http://water.usgs.gov/nawqa/xrel.pdf). Since its inception, the NAWQA Program has emphasized (1) the development of innovative and science-based monitoring designs and assessment techniques to assess the quality of the Nation's rivers, streams, and ground water; (2) a commitment to high-quality products that are readily available and responsive to stakeholder needs; and, (3) continuous collaboration and liaison with government, research, and interest-group partners to ensure relevance to local, State, regional, and national water-resource issues.

III. Program Objectives, Approach, Progress, and Five-Year Scientific Investigations

Objectives — The objectives of NAWQA are to assess the status and trends of national water-quality conditions and to understand the factors and processes that govern those conditions, thus, addressing the questions:

1. What is the quality of the Nation's streams and ground water?
2. How is water quality changing over time?
3. How do natural factors and human activities affect the quality of streams and ground water?

Approach —Characteristics that define the NAWQA Program include:

- A nationally consistent study design and methods so that water-quality conditions can be compared on a State, regional and national basis.
- Long-term and cyclical activities so that trends in water quality can be analyzed to determine whether conditions are getting better or worse.
- Interdisciplinary approach, including chemistry, hydrology, geology, aquatic ecology, physical geography, and statistics.
- Relations of human activities (contaminant sources, land use, and chemical use) and natural factors (soils, geology, hydrology, and climate) to water quality, aquatic life, and stream habitat so that findings contribute to improved management and protection of drinking water and aquatic ecosystems.
- Assessment of water-quality conditions in relation to potential effects: (1) in a human-health context so that findings help to assess and protect the quality of source water and finished water associated with many of the Nation's drinking-water supplies; and (2) in an aquatic-health context so that findings help to assess and protect the quality of stream ecosystems.
- Integration of modeling and other scientific tools with monitoring so that water-quality understanding can be extrapolated to unmonitored areas, trends can be forecasted, and future water-quality conditions can be better anticipated as a result of various resource- and land-management scenarios.
- Integration of data from other organizations into NAWQA assessments, where appropriate, so that findings more comprehensively span geographic and temporal scales.

- Collaboration and liaison with government officials, resource managers, industry representatives, and other interested parties to increase relevance to decision makers.
- Readily accessible information that meets water-resource needs of a wide range of stakeholders through diverse formats.

Progress—From 1991-2001, the NAWQA Program conducted interdisciplinary assessments and established a baseline understanding of water-quality conditions in 51 of the Nation's river basins and aquifers, referred to as Study Units. Scientists in each Study Unit collected and assessed information on contaminants and other chemicals in streams and ground water, including pesticides, nutrients, volatile organic compounds (VOCs), and trace elements, as well as on hydrology, land use, stream habitat, and aquatic life. NAWQA findings described the general condition of water resources, as well as current and emerging water issues. Each assessment was guided by a nationally consistent study design and methods of sampling, database management, and analysis, thus providing a national analysis of water quality across the U.S.

Since 1991, much progress has been made towards its first objective of assessing and reporting on the status of water quality. Descriptions of specific aspects of water-quality conditions in streams and ground water have been provided in more than a thousand reports (http://water.usgs.gov/nawqa). In particular, comprehensive summary reports (USGS Circulars), written for a broad audience consisting of those interested or involved in resource management, conservation, regulations, and policy, were completed for each of the 51 Study Units (http://water.usgs.gov/nawqa/nawqa_sumr_complete.html).

Comprehensive summary reports were also completed at the national scale on pesticides, nutrients, and VOCs (http://water.usgs.gov/nawqa/nawqa_sumr.html). These national reports synthesized and compared findings in the 51 Study Units, yielding major advances in understanding of the quality of waters across the Nation. Water-quality conditions were assessed in relation to human activities, land use, and natural factors that can affect water quality and ecological health in the Nation’s diverse geographic and environmental settings. In addition, observed conditions were compared to national water-quality standards, guidelines, and benchmarks to assess the potential effects of water-quality conditions on human health and aquatic life.

Studies during the Program’s second cycle (2001-2012) cover 42 of the 51 Study Units (scaled back and scoped to fit within the level funding during the Program’s second cycle). The reduced set of Study Units continue to represent a high percentage of population served by municipal water supply and irrigated agriculture, accounting for more than 60 percent of water used for drinking and irrigation and include a wide range of hydrologic environments, ecological resources, and critical land uses and contaminant sources (including agricultural, urban, and natural sources).

Since 2001, NAWQA has progressed toward the second objective of assessing long-term trends. For example, long-term trends have been assessed for persistent contaminants in sediment and fish, such as DDT, PCBs, and lead, as well as for other contaminants for which historical data were available. Most importantly, baseline water-quality conditions were established between 1991 and 2006 for comparison to future conditions. The major thrust for evaluating trends will occur during the next five years when an increasing number of stream and ground-water sampling sites will have more than 10 to 15 years of consistent monitoring data available for trend analysis.

NAWQA has also progressed since 2001 toward the third objective of assessing how natural processes and human activities affect the quality of streams and ground water. NAWQA studies have consistently shown, for example, how contaminant levels vary from season to season and among watersheds because of differences in land and chemical use, land-management practices, degree of watershed development, and natural features, such as soils, geology, hydrology, and climate. The major thrust for understanding key processes that control water-quality conditions will continue during the next five years, with focus on the links among *sources* of contaminants and other disturbances that degrade water quality, *transport* of contaminants through the hydrologic system, and the potential *effects* of contaminants and other water-quality disturbances on aquatic ecosystems and human health. To the extent possible, findings will be placed in the long-term context to help sort out the effects of natural variability from the effects of human activities.

Science Focus over the Next Five Years: The NAWQA Program will primarily focus on the following types of scientific investigations:

- Continued national-synthesis assessments on nutrients, aquatic ecology, trace elements, pesticides, and, to a lesser extent, VOCs.
- Regional and national assessments of status and trends. These assessments focus on surface-water-quality in the 42 Study Units grouped within 8 major river basins in the U.S.; ground-water-quality in about one-third of the Nation's 62 principal aquifers; and source-water-quality in drinking-water supply wells, stream intakes, and in finished water associated with about 50 large community water systems.
- Topical studies of national water-quality priorities that focus on understanding: (1) the fate and transport of agricultural chemicals, (2) effects of urbanization on stream ecosystems, (3) effects of nutrient enrichment on stream ecosystems, (4) bioaccumulation of mercury in stream ecosystems, and (5) transport of contaminants to public-supply wells.

The NAWQA Program considers three areas integral to the success of its scientific investigations over the next five years, including the development of models, increased integration of data from other programs and organizations, and increased collaboration with other USGS disciplines:

- The development and application of models are integral to each of the NAWQA investigations. The models rely on monitoring data collected at individual sites and in networks and on extensive development and analysis of geographic data on hydrologic characteristics, land use, and contaminant sources. The integration of modeling with monitoring helps to extend water-quality understanding to unmonitored areas, including major river basins and principal aquifers beyond the boundaries of the 42 Study Units. The models are useful in evaluating resource- and land-management scenarios and in predicting how protection actions and land-use decisions are likely to affect water conditions within certain geographic regions or in the future.
- Also integral to NAWQA scientific investigations over the next five years is increased integration of data collected through other USGS programs, such as the National Stream Quality Network (NASQAN), and that build on partnerships with other governmental agencies (Federal, State, regional, and local), nongovernmental organizations, industry, and academia. External coordination at all levels has been recognized since the inception of the NAWQA Program; however, acknowledgement that cost-effective management of

water resources requires more information than is available currently at Federal and State levels, supports an even stronger Program focus on data integration.

- NAWQA recognizes the overlapping and interdisciplinary components of physical, chemical, and ecological processes affecting water conditions, and the role of the landscape, including land use (and historic changes), geology, soils, climate, and human activities, on water quality. Therefore, the Program seeks to promote collaboration and integration of our expertise with scientists across USGS disciplines to the extent possible to achieve a system-scale understanding of the natural and anthropogenic factors affecting our waters. A multitude of USGS Programs are relevant to NAWQA objectives, including but not limited to, the:

  1. Ground-Water Resources Program, Water Use Program, Toxic Substances Hydrology Program, Cooperative Water Program, and National Research Program in the Water Discipline.
  2. Geographic Analysis and Monitoring (GAM) program in the Geography Discipline, whose goal is to provide a national and global perspective on land-surface change;
  3. Geography Discipline's national land-use databases for mapping irrigated agriculture, urban areas, population density, and recreation areas; and technical operations center for hydrography (NHD), elevation (NED) and stream delineation (EDNA);
  4. Geography's Land Cover Trends Project, FORE-SCE land use modeling, Integrated Landscape Monitoring (ILM) science thrust, the Global Integrated Trends Analysis Network (GITAN), National Ecosystem Mapping projects, and the Geospatial Decision Support System Model research project;
  5. Biological Resources Discipline programs for Contaminant Biology, Ecosystems, Fisheries and Aquatic Resources, and Status and Trends of Biological Resources; NBII, and Aquatic GAP.
  6. Individual projects within Biological Science Centers across the Nation;
  7. Geologic Discipline's Geologic Mapping, Energy, Minerals, and Coastal Geology Programs; and
  8. National Geospatial Program and the National Map.

Findings generated through the activities listed above will be integrated, as appropriate, to address a wide range of water-quality issues, particularly those related to the conditions and trends in the quality of water and potential effects on human health and aquatic ecosystems. Studies of trends, governing processes, and the quality of source water will provide additional insights on (1) the quality of water in public-supply and domestic wells; (2) the role of hydrology and contaminant transport on water quality and ecosystem health; (3) effects of agriculture and urbanization on aquatic health; (4) changes in selected contaminants in streams and ground water over time; and, (5) the co-occurrence (or "mixtures") of contaminants and their relevance to aquatic and human health. NAWQA information will thereby continue to support the USGS 10-year Science Strategy, particularly relating to understanding ecosystems change, understanding of the role of the environment in human health, and securing available freshwater for America's future.

IV. Program Elements

The NAWQA Program is organized by five major elements that cover the large breadth of scientific investigations, technical support, and outreach. Specifically, the five Program elements are: 1) National-synthesis assessments, 2) Regional and national assessments of status and trends, 3) Topical studies of national water-quality priorities, 4) Technical support, which includes process understanding, methods development and modeling; and 5) Outreach, which includes partnerships, liaison activities, and communication strategies. Specific objectives, budget, and expected outcomes and products for each of the Program elements are presented. In total, these Program elements are expected to remain stable-funded at about $63 million each year over the next five years.

Program Element 1 – National-Synthesis Assessments

Objectives

NAWQA provides comprehensive and consistent data to allow national comparisons. National teams will continue to synthesize findings to address specific national-scale water-quality issues related to nutrients, stream ecology, trace elements, pesticides, and to a lesser extent, VOCs. Primary objectives of individual synthesis efforts are listed below followed by information on selected cross-cutting products.

1. ***Nutrients and Trace Elements***

Assess the status and trends of nutrient concentrations in streams across the Nation through monitoring and modeling (including improvement of the USGS models: SPARROW (SPAtially Referenced Regression On Watershed attributes) and WARN (WATershed Regression on Nutrients).

- Estimate nitrate concentrations and risk in shallow ground water and aquifers across the Nation through monitoring and modeling.
- Identify long-term trends in nutrients in ground water used for drinking-water supplies.
- Synthesize and report on the role of hydrology, including surface-water and ground-water relations, in explaining nutrient concentrations and transport in and between aquifer and stream systems.
- Model linkages between sources of nutrients (non-point and point), factors controlling nutrient transport, and nutrient concentrations and loads in streams.
- Model linkages between water quality and agricultural sector changes associated with increases in the production of biofuel crops.
- Synthesize and report on trace elements in fish tissue and bed sediment in streams across the U.S.
- Synthesize and report on arsenic and radionuclides in ground water in principal aquifers across the U.S.

2. Aquatic Ecology

- Synthesize and report on the status and trends of aquatic ecological conditions (invertebrates, fish, and algae and habitat) in rivers and streams.
- Relate ecological conditions to chemical stressors, physical disturbances, environmental settings, land use/land cover, and hydrology.

- Enhance understanding of factors that influence the biological integrity of streams and how stream ecosystems may respond to diverse natural and human factors.
- Develop key ecological indicators of aquatic health and populate these indicators with NAWQA data.

3. ***Organic and Trace Element Contaminants in Sediments (http://tx.usgs.gov/coring/index.html)***

- Statistically evaluate patterns and long-term trends in contaminants in lake bed sediment in lakes in urban and undeveloped areas.
- Synthesize and report on trends in polycyclic aromatic hydrocarbons (PAHs) in urban settings related to changes in urbanization and other land-use patterns.
- Determine pre-European background levels of trace elements in selected settings across the U.S.
- Assess trends in anthropogenic short- and long-range atmospheric fallout of trace elements and PAHs in selected undeveloped ("reference") lakes across the U.S.
- Develop a toxicity index approach to assess trends, aligned with the consensus-based sediment quality guidelines.
- Statistically relate occurrence of contaminants in lake sediment cores to those in streambed sediment in contributing streams and tributaries.
- Develop relations between contaminant levels and sources
- Determine the need to resample stream-bed sediments and fish tissues for detection of decadal trends and occurrence of new compounds

4. ***Pesticides***

- Synthesize and report on the national distribution and concentrations of pesticides in unmonitored streams in agricultural areas. Estimates will be made using the USGS statistical model, WARP (WAtershed Regression on Pesticides), which was developed from NAWQA monitoring data and extensive geographic information.
- Synthesize and report on the characteristics and distribution of pesticide mixtures.
- Synthesize and report on conditions and trends in concentrations for selected pesticides in specific land-use settings, focusing where possible on selected pesticides with significant use reductions or increases and on those pesticides scheduled for re-registration and registration review decisions.
- Evaluate correlations between pesticide levels in streams and observed impairment of aquatic ecosystems.

5. Volatile Organic Compounds (VOCs)

- Synthesize and report on decadal trends in selected VOCs in ambient ground water and source water used for drinking purposes.
- Synthesize and report on trends in methyl tert butyl ether (MTBE) concentrations in selected community water systems.

- Synthesize and report on the occurrence of VOCs and their mixtures in urban streams, and determine natural and anthropogenic factors that are associated with the occurrence of frequently detected compounds.
- Describe the similarities and differences of VOC occurrence in urban streams and ground water, including the most prevalent compounds, chlorinated solvents, gasoline hydrocarbons, and trihalomethanes (THMs).
- Include expanded development and application of USGS Health-Based Screening Levels (HBSLs http://water.usgs.gov/nawqa/)

6. Cross-Cutting Syntheses At least one cross-cutting theme, source water and drinking-water quality in a human health context, is planned for synthesis activities. Cross-cutting activities focus on integrating data and products across the objectives of NAWQA from national synthesis, to local and regional status and trend assessments, source-water quality assessments, and five topical studies of national priority, and other relevant information from outside the Program.

- Characterize the co-occurrence (nature and composition) of pesticides, VOCs, and other compounds in source waters, in treated water from surface and ground-water public supplies, and in private drinking water wells; and their relations to land use, natural features, water use, well use, and other factors.

Budget—Annual support for National Synthesis is expected to remain about $7 million.

Expected Products and Outcomes – Expected outcomes will contribute to a comprehensive national-scale perspective on the distribution of water-quality conditions across the Nation and the factors, such as agricultural and urban land uses, that govern water quality (http://water.usgs.gov/nawqa/natsyn.html). National synthesis products and publications will provide land and water management agencies and policy makers at all levels with information relevant to water-quality and land-management practices to protect and enhance drinking water and stream ecosystems. Organizations using NAWQA information will gain insight into the effectiveness of selected actions taken to reduce and control pollutant loading from land use and land practices to the water environment as well as identify new and unanticipated changes from land use and land-management practices that may warrant attention now or in the future.

- Two comprehensive summary publications; the first will describe aquatic ecological conditions and the second will describe the occurrence and distribution of nutrients in streams and ground water across the Nation. These synthesis documents will be published in the USGS Circular series "The Quality of Our Nation's Waters." These reports will discuss nutrient and ecological conditions in terms of status, trends, natural and human factors, and implications for management and decision making. The consistent, multi-scale approach allows direct comparisons of how human activities, land use, and natural factors affect water quality and ecological health in the Nation's diverse geographic and environmental settings. Water-quality conditions will be compared to national water-quality statistics as well as considered against national water-quality standards and guidelines related to drinking water, protection of aquatic life, and nutrient enrichment.
- A national summary publication on trends in organic and trace-element contaminants in lake sediment. Findings on sources, transport, and fate of selected contaminants will be highlighted, such as the role of pavement coatings and sealers used on parking lots and

driveways in elevating PAHs in urban streams. Implications of the findings for stream and aquatic health protection, resource management, ecological indicators of urbanization and stream impairment, and monitoring trends will be included.

- Other interpretative and non-technical reports/articles describing water-resource topics (listed above) and water-management implications at the national scale.
- Technical reports in peer-reviewed journals and USGS report series that report scientific findings (on topics described above) to technical audiences.
- Documentation and application of national models, such as SPARROW and WARP, which will help to predict nutrient and pesticide concentrations in unmonitored areas; generate time-series daily concentrations for selected compounds; estimate the amounts (or "loads") of nutrients and sediment transported down streams to estuaries and other receiving waters; link sources (non-point and point) and landscape features to contaminant detections, concentrations, and (or) loads; and, forecast conditions related to resource- and land-management scenarios.

Program Element 2-Regional and National Assessments of Status and Trends

Objectives

During the next five years, status and trends of surface-water-quality will be assessed within eight large geographical regions, referred to as "major river basins" covering the U.S. (http://water.usgs.gov/nawqa/mrb/). Status and trends of ground-water-quality will be assessed within about one-third of the Nation's 62 principal aquifer systems (http://pubs.usgs.gov/fs/2005/3013/). Results will be reported by major river basin and principal aquifer system, as well as selected topics will be compared across the regional systems for a national perspective. The reports will highlight regional differences in land use, chemical use, geology, and climate that lead to regional differences in water quality.

NAWQA's approach to assessing status and trends during the next five years requires several modifications to its approach prior to 2006, including: (1) a shift in the scale of data analysis and reporting from 42 Study Units to 8 larger "major river basins" and principal aquifers; (2) incorporation of modeling with monitoring to help extend water-quality understanding of conditions, sources, and transport to unmonitored, yet comparable areas; and, (3) collaboration and integration of data from other government agencies (Federal, State, regional, tribal, and local), as well as nongovernmental organizations, industry, and academia. Such modifications help to meet funding reductions and to maximize the use of its stream-monitoring information for broad water-resource understanding.

Source-water-quality assessments in about 50 public water supplies will be conducted to characterize the occurrence and distribution of about 270 compounds, including pharmaceuticals, personal care products, industrial chemicals, pesticides, and microbes, in selected drinking-water supply wells, stream intakes, and in finished drinking water associated with large community water systems. The assessments are intended to complement drinking-water monitoring required by Federal, State and local programs, which focus primarily on post-treatment compliance monitoring. Considering the relatively small number of assessments, the findings are not intended to comprehensively portray the quality of our Nation's source waters, but rather are intended to improve understanding of ambient resource assessments in a drinking-water context.

Individual community water systems will not be specifically identified in assessment publications for security purposes.

Major River Basins – Stream-water quality and aquatic ecology

- Monitor status and trends in stream water quality at about 117 stream sites spanning 8 major river basins using a rotational sampling scheme, with sampling intensity varying year to year at different sites.
- Monitor trends in aquatic ecological conditions and in-stream and near-stream habitat at 58 wadeable stream sites across the Nation.
- Integrate NAWQA surface-water quality network operation and data analysis with the USGS National Stream Quality Accounting Network (NASQAN) in 2008, thereby creating a Federal Surface-Water Quality Fixed Station Network. This integrated network will provide enhanced information on streamflow and transport of nutrients, sediment, and other compounds to the Gulf of Mexico and other sensitive coastal receiving waters.
- Assess status and trends in water quality through the integration of monitoring at individual sites with modeling in selected major river basins (using SPARROW, WARP, and WARN), resulting in increased understanding of water-quality conditions (such as nutrient and pesticide concentrations), sources, and transport, and in extended knowledge of water quality in unmonitored, but comparable streams.
- Synthesize and report on results of regional-scale SPARROW models estimating flux of nitrogen and phosphorus to the northern Gulf of Mexico and coastal areas along the Atlantic Ocean.
- Characterize the status of aquatic ecological conditions in wadeable streams through the integration of NAWQA data with spatially extensive, statistical estimates available from other USGS, and selected State and EPA monitoring programs. Publish the results of the pilot study in the Pacific Northwest demonstrating ecological modeling approaches.
- Synthesize and report on changes and trends in aquatic ecological conditions related to changes in concentrations of pesticides and nutrients, habitat, and hydrologic variation and modifications.
- Initiate and report on a reconnaissance survey of mercury in fish in streams throughout the Nation to fill in gaps in historic data.

2. Principal Aquifers – Ground-water quality

- Evaluate ground-water-quality conditions and trends in about 20 principal aquifers across the Nation, and relate those conditions and trends in ground-water quality data to natural and human factors, including aquifer characteristics, geology, pumping, and land-use activities. Evaluations will cover, for example:
  - ✓ Occurrence of nutrients, pesticides, VOCs, arsenic and other trace elements, radionuclides, and major ions in selected principal aquifers.
  - ✓ Occurrence of natural and anthropogenic chemicals in domestic and public-supply wells.
  - ✓ Ground-water quality related to agricultural and urban land use.

- ✓ Trends in concentrations of nutrients, pesticides, and selected VOCs in ground water related to factors, such as principal aquifer characteristics, land-use activities (agriculture and urbanization), and pumping and recharge, where possible.
- ✓ Lithology of selected surficial geologic units and relations of ground-water quality to rock type and dissolution of minerals, in large part through collaboration with scientists from the USGS Geologic Discipline scientists. This effort will improve understanding of the natural occurrence of toxic contaminants, such as arsenic, in select aquifers and geographic regions of the country.
- ✓ Links between water quantity, quality, and water use by aquifer system, in large part through collaboration with scientists from the USGS Ground-Water Resources and Water Use Programs. The linkages are important because the amount and timing of water use, particularly in areas of extensive irrigated agriculture, large and densely populated urban areas, and recreational areas, affect the timing and movement of contaminants to and within aquifers.
- ✓ Relations between constituent concentrations to their relative locations along ground-water flow paths in the aquifer, from recharge areas to discharge areas, in large part through collaboration with scientists from the USGS Ground-Water Resources Program. Initial studies will be completed in the Denver Basin and Mississippi Embayment aquifer systems.

3. Source-water-quality assessments

- Assess the year-round presence of about 270 anthropogenic organic compounds, including pharmaceuticals and personal care products as USGS methods become standardized, in selected stream intakes and finished water in up to 20 streams, relative to seasonal variability and hydrologic events when water quality may change quickly and (or) when large concentrations are most likely to occur. Add pharmaceuticals and personal care products as USGS methods become standardized and as resources permit.
- Assess one-time contaminant occurrence of about 270 anthropogenic organic compounds, in 15 high-production wells supplying community water systems and the associated finished water in each of the 30 different areas. Add pharmaceuticals and personal care products as USGS methods become standardized and as resources permit.
- Assess natural and anthropogenic factors and possible sources associated with the detection of selected organic compounds in community water supplies.

Budget – Support for Regional Assessments is planned to keep pace with inflation in years when the Program receives positive budget adjustments, over the next five years. Currently, the effort is about $23 million with about $11 million each for assessing status and trends in streams and ground water; and about $1 million for source-water quality assessments. Keeping pace with inflation is critical to the ongoing sustainability of assessments of current conditions and trends in stream and ground-water quality.

Expected Products and Outcomes – At the regional, state, and local scales, water-quality managers, water purveyors, and State and Interstate Agencies will be provided with information, models, and tools for development of TMDLs, source-water protection plans, and other actions to improve water quality. NAWQA information will provide a scientific basis for informed decision making on land- and water-management practices, land-use change decisions, and protection strategies for sensitive receiving waters. These assessments address the needs for

information on nutrient and contaminant loadings identified in the President's Ocean Action Plan, Gulf of Mexico Hypoxia Task Force Plan, and needs identified by EPA under the Clean Water Act. The ground water assessments support information needs identified by EPA, the Source-Water Collaborative, water purveyors, and others to support Safe Drinking Water Act. Products include:

- Interpretative and non-technical reports/articles describing individual topics (described in objectives above) and water-management implications at the regional and state scales.
- Technical reports in peer-reviewed journals and USGS report series that report scientific findings (on topics described above) to technical audiences.
- A series of summary publications (USGS Circulars), written primarily for those interested or involved in resource management, conservation, regulations, and policy, that describe ground-water conditions and trends, to the extent possible, in water quality for selected principal aquifers, including, for example, the High Plains Regional Aquifer system and the glaciated aquifer systems that cover much of the northern part of the U.S.
- Two national summary publications describing water quality in (1) public supply wells and (2) domestic (private) wells across the Nation, covering the individual occurrence of 220 compounds and commonly occurring mixtures of compounds.
- Two national summary publications describing water quality of source water and treated water in public water systems supplied by streams and ground water. Interpretative USGS reports and fact sheets and journal articles describing the quality of source water and finished water, with implications for state and local source-water and wellhead protection strategies.
- Identification of compounds common in finished water and future needs for research and technology by other agencies and (or) organizations] to remove/limit these compounds in finished water.
- Regional- and national-scale models and decision-support tools, built upon a foundation of USGS, other Federal, and State monitoring data, that can be used to predict nutrient and pesticide concentrations in unmonitored streams and to estimate the amounts (or "loads") of nutrients and sediment transported in streams to estuaries and other receiving waters. Examples are a SPARROW model for the Mississippi River Basin, Great Lakes, Pacific Northwest, Gulf and Atlantic coasts that estimates nutrient fluxes to coastal receiving waters.
- Regional- and watershed-scale models that can be used to predict ecological conditions in wadeable streams in unmonitored areas of the Pacific Northwest.
- Regional-scale ground-water models that increase understanding of conditions and vulnerability of ground water and its availability as constrained by quality.
- Integrated and improved monitoring designs that represent multiple programs and organizations.

Program Element 3- Topical Studies of National Water-Quality Priorities

Objectives

Topical studies of national water-quality priorities are conducted to improve understanding of governing processes affecting water quality and to help explain and predict water quality conditions and trends. It is insufficient to know only where and when certain contaminants and

conditions occur in the Nation's waters. It is essential for effective management and for positive outcomes to know why and how conditions exist, the contributing factors, sources, natural and human pathways, and the fate and transport processes that control and influence conditions and trends. Specifically, the Program is addressing five national priority topics that establish links between *sources* of contaminants, the *transport* of those contaminants through the hydrologic system, and the potential *effects* of contaminants on human health and aquatic ecosystems. The five topical studies are conducted in selected Study Units most affected by the issues (consisting of about eight Study Units per topic during the next five years) (http://water.usgs.gov/nawqa/national_topical_studies.html). Specific objectives for each topical study are listed below.

- ***Effects of nutrient enrichment on agricultural streams***
  - ✓ Assess relations between nutrient conditions and biological communities in streams draining different agricultural settings and determine the role of hydrology, riparian systems, and physical habitat on nutrient concentrations and biota.
  - ✓ Assess relations between nutrients, algae, and stream metabolism in streams.
  - ✓ Determine the role of hydrology, riparian systems, and physical habitat on nutrient concentrations and biota.
  - ✓ Develop algal and invertebrate indicators of nutrient conditions.
- ***Sources, transport, and fate of agricultural chemicals***
  - ✓ Evaluate hydrologic controls on chemical transport through agricultural watersheds.
  - ✓ Determine environmental processes and agricultural practices that affect the transport and fate of chemicals in streams, ground water, and the unsaturated systems in agricultural settings.
  - ✓ Assess herbicide concentrations during peak-application seasons when the potential for acute toxicity would be most probable.
  - ✓ Determine the role of atmospheric deposition on pesticide concentrations in agricultural watersheds.
- ***Transport of contaminants to water supply wells***
  - ✓ Determine the role of selected natural and anthropogenic sources (non-point, septic systems, highways, storm water) on contaminant occurrence in public-supply wells.
  - ✓ Assess the transport mechanisms that affect the vulnerability of public-supply wells to contamination and the importance of short-circuit pathways and human factors.
  - ✓ Develop relations between water quality in aquifers and water quality in public-supply wells (where and how contaminants actually enter public-supply wells).
  - ✓ Determine indicators of public-supply-well vulnerability to contamination, including assessment of ground-water age as an indicator of vulnerability and possible relations between ground-water ages, the quality of public-supply water, and human health.
  - ✓ Forecast consequences of land-use changes on the quality of water in public-supply wells, as well as the timeframes necessary for such changes to be fully realized.
- ***Effects of urbanization on stream ecosystems***

- ✓ Assess the response of stream ecosystems to land-use changes associated with urbanization.
- ✓ Evaluate variability in urban stream ecosystem responses across different environmental and hydrologic settings—why some urban streams are more vulnerable than others.
- ✓ Develop improved biological indicators for assessing effects of urbanization on streams.
- ✓ Evaluate the role of physical and chemical factors and key urban landscape features (such as road density and percent impervious area) that affect ecosystem responses.
- ✓ Develop empirical models to relate physical, chemical, and biological responses to landscape features associated with urbanization.
- ✓ Complete and publish information on a pilot study to better understand the water-quality and urban contaminant effects of urbanization on stream ecosystems. The pilot study will emphasize biological endpoints for fish and macroinvertebrates from chemical contaminants such as pesticides, PAHs, and other trace-level organic contaminants. The study will be undertaken in collaboration with the USGS Columbia Environmental Research Center and the National Research Program.

- ***Bioaccumulation of mercury in aquatic organisms***
  - ✓ Improve our understanding of environmental and biological factors that govern the transformation of mercury to methylmercury.
  - ✓ Quantify the cycling and mass balance of mercury and methylmercury in stream ecosystems, including inputs from the atmosphere, uplands, and wetlands, methylmercury production, and methylmercury degradation within selected streams.
  - ✓ Evaluate the occurrence of methylmercury in predator game fish, such as bass and trout, across the Nation. Compare methylmercury bioaccumulation in fish in urban and undeveloped watersheds. Assess the transfer of methylmercury from the base of the aquatic food web to predator game fish.

Budget—Topical Studies are expected to remain at about $11 million per year divided equitably among the five topics.

Expected Products and Outcomes – Reports will compare and contrast findings from the multi-Study Unit design, thereby yielding opportunity for synthesis of findings. Syntheses will provide an enhanced understanding the factors affecting the Nation's waters. Understanding and quantification of water-quality processes will be used to improve existing water-quality models and to develop sensitive indicators of vulnerability. The outcomes are improvement in predictions and forecasts of water-quality conditions and trends, improved simulations of various management scenarios and predict responses, useful indicators of ground-water vulnerability based on controlling factors, and improved models of stream ecosystem response to changing land use, nutrients and pesticide concentrations, and land-management practices. Improved management decisions will be possible on issues ranging from TMDLs and nutrient criteria to public-water supply and ground-water management, and well-head protection.

Interpretative USGS reports such as circulars, fact sheets, lay reader articles, and scientific journal articles on the five national priority topics listed above, featuring, for example synthesis publications on:

- Journal articles and a USGS Circular on nutrient, algal (chlorophyll a), and biological conditions in agricultural streams and the role of hydrology and riparian systems affecting those conditions, with implications for development of biological indicators of nutrient enrichment, regional nutrient criteria, and reference values in streams for the protection of aquatic health.
- A highly visible scientific publication describing the role of hydrology and contaminant transport on water quality in agricultural streams, with implications for evaluating best management and conservation practices.
- Journal articles containing new information on the fate and transport in small watersheds of glyphosate, the herbicide used in increasing quantities on agricultural and genetically-modified crops.
- Journal articles and two Circulars on effects of sources, natural and anthropogenic factors, land-use changes, and transport mechanisms on the occurrence of contaminants in public-supply wells, with implications for source-water protection, ground-water management, future resource development, improved monitoring strategies (related to depth and timing) that can lead to increased protection of human health.
- Journal articles and a USGS Circular on effects of urbanization on ecosystem health, with implications for stream protection strategies, land- and water-resource management
- Journal articles and a USGS Circular on factors affecting mercury and methylmercury and bioaccumulation in fish in diverse stream ecosystems across the Nation, with implications for fish-consumption advisories, mercury emissions, and improved monitoring strategies for mercury.
- Nutrient-biota predictive models that can be applied regionally and help in the development of nutrient criteria by States and EPA.
- Regional and national indicators of urbanization that predict stream conditions with respect to aquatic invertebrates.
- Models, decision-support tools, and practical indicators of vulnerability of ground water in public-supply wells, which can be used for source-water protection, resource development, and measurement of the effectiveness of protection efforts on ground-water-quality over time.
- Applications of available models (such as those developed by the EPA National Environmental Research Laboratory in Athens, Georgia) to describe the mass balance of mercury and methylmercury in stream ecosystems and the bioaccumulation of methylmercury in game fish.
- Predictive models of one or more measures of ecological response to urbanization, which can help to evaluate potential effects of management strategies.

Program Element 4- Technical Support

Objectives

Efforts will continue to develop and apply modeling capabilities and spatial assessment approaches, as well as continue to develop improved laboratory methods for expanded coverage of contaminants and improved analytical methods for understanding processes governing water quality. These efforts cross cut and are integral to all NAWQA activities described above in Program Elements 1 through 3.

- *Process understanding*- NAWQA, in concert with scientists in the USGS National Research Program, will continue systematic and quantitative analysis of key chemical and biological processes affecting water quality, such as stream metabolism, denitrification, methylation-demethylation, disinfection by-products, redox (or "reduction and oxidation"), recharge rates, mercury bioaccumulation and biogeochemistry, and contaminant degradation. Innovative research techniques, such as those involving age-dating, dye tracer tests, tracer gas reaeration, and isotope analysis will be applied to better understand contaminant transport and fate such as bioaccumulation in food webs. In addition, the scientists will explore linkages between hydrologic processes and water quality to provide a unified view of hydrologic controls on water quality (such as the effects of transport through the unsaturated zone).
- *Methods development*- NAWQA, in concert with other USGS Programs, such as the National Water-Quality Laboratory, National Research Program, and the Toxic Substances Hydrology Program, will continue development of state-of-the-art methods to ensure NAWQA data collection and analyses are relevant to emerging issues. The scope of contaminants for national assessment will incrementally increase as important issues are identified and methods are developed. Three main categories of contaminants will be included: 1) selected new pesticides with high usage, pesticide degradates, and pharmaceuticals in agricultural and populated areas across the Nation; 2) indicators of water-borne diseases in streams and ground water that are sources of drinking water and in streams that are used for water-contact recreation; and 3) total mercury and methylmercury in media sampled to understand human exposure through the consumption of fish.
- *Spatial framework* – NAWQA will continue to develop and collect spatial (or "ancillary") information on factors that govern water quality, such as soil, land cover, climate, and topography, and apply these data in the analysis of water-quality conditions. Some of these data originate outside the USGS, while other data is developed in conjunction with EPA, USDA, and the USGS Geography Discipline, including land cover (NLCD), hydrography (NHD), elevation (DEM), and stream delineations. NAWQA also will continue to support the research, development, and application of spatial frameworks such as hydrologic landscapes and ecoregions. These frameworks are the foundation for the development of NAWQA monitoring networks, the syntheses of water-resources data at multiple scales, the comparison of processes and findings across environmental and land-use settings, and the extrapolation of water-quality findings to unmonitored streams and aquifers across the U.S.
- *Modeling*- NAWQA's Hydrologic Systems Team, in concert with scientists in the USGS National Research Program and academia, will continue to develop and support water-quality and landscape models at all scales, essential to all scientific activities of the Program. These include regional and national watershed regression and ground-water

statistical-vulnerability models; watershed models; vadose-zone models; water-balance models; flow-path and fate and transport models; and metabolism models. Modeling is an integral component to the success of all NAWQA activities. Integrated with on-the-ground monitoring, the models allow a better understanding of sources, transport, and effects in streams, in the large watersheds and receiving waters, in ambient ground water, and in source water used for drinking. Modeling is integral to understanding water quality in context with land-use and contaminant sources, natural characteristics of the land, and hydrologic transport processes; in predicting conditions in unmonitored, but comparable settings; and in forecasting water-quality conditions for the future.

- *Data dissemination and integration* —Capabilities of the NAWQA Data Warehouse will continue to be enhanced during the next five years, including improved user-friendly and interactive maps, graphics, and data retrievals. A greater emphasis will be placed on developing new tools that support and enhance the dissemination and use results of water-quality models. These enhancements include development and release of decision support systems to make model results readily available for use within and outside USGS. An enhanced system for data entry, storage, and retrieval of aquatic biological information will be developed and implemented. This system will integrate stream ecological data on algae, aquatic macroinvertebrates, fish, and instream and near stream habitat from all USGS water programs and will serve as the NWIS for Aquatic Biology. In addition, data will continue to be shared through partnerships, such as Consortium of Universities for the Advancement of Hydrologic Sciences (CUAHSI; http://www.cuahsi.org) and EPA's STORET system (http://www.epa.gov/storet/future_storet.html).

- *Technical Assistance for USGS water-quality activities* — The USGS has a long tradition of providing national technical support and training for its geographically distributed water-quality studies. This support provides quality control to assure the technical excellence of water-quality field programs and provides a structured way of transferring new technology to investigative and data activities that are primarily conducted in USGS Water Science Centers in each State. Technical support also includes a formal way of establishing priorities for water-quality research by the USGS and provides a mechanism to make water-quality information available to other agencies, the scientific community, and the public.

Budget—Technical Support is expected to increase slightly with inflation to about $19 million per year; with about $6.5 million for process understanding, $2.0 million for water-quality methods development, $7.5 million for technical assistance, $1.5 million for data dissemination and integration, and $1.5 million for modeling and spatial framework.

Expected Products and Outcomes: USGS and our partners in other federal and in State and local agencies will have critical data, information, tools, and models for managing pesticides, nutrient enrichment, urbanization, ground water and drinking-water quality, and other issues resulting in an overall benefit to human health and aquatic life. Specifically, these activities will result in

- Spatial landscape data and hydrogeologic frameworks.
- Model documentation and applications and decision-support tools.
- Coordinated model approaches across multiple scales and water-quality issues.
- Development of new methods for analysis of pesticides, pharmaceuticals, hormones, and personal care products, and microbial pathogens and their indicators.

- Increasing levels of integration of data systems such as the NWIS-Web, NAWQA Data Warehouse and the enhanced biological system, National Map, NBII, and EPA's STORET.

Program Element 5—Outreach

Background

The NAWQA Program was designed to ensure an unbiased scientific basis to address a broad range of water-quality issues, such as those related to agricultural and urban watersheds, drinking water, recreation, source-water protection, aquatic health, nutrient enrichment, stream protection and restoration, and monitoring and sampling strategies (http://water.usgs.gov/nawqa/xrel.pdf). Specific applications of NAWQA information has resulted, for example, in improved:

- Development of regional nutrient criteria and reference values in streams for the protection of aquatic and human health;
- Development of chemical and ecological indicators of stream impairment, and ecosystem and human health;
- Pesticide registration and re-registration;
- Development of TMDLs, or Total Maximum Daily Loads;
- Source-water and wellhead protection strategies;
- Ground-water management areas;
- Identification of sources and issues related to natural and human influences, particularly those related to agriculture and urban land uses;
- Standards and guidelines for aquatic health and water-quality benchmarks, such as HBSLs) for unregulated contaminants;
- Information for pesticide registration and contaminant regulations; and,
- Prioritization of streams, aquifers, and geographic regions for cost-effective monitoring, protection, and management.

Key customers cover a broad and varied audience, including, for example, scientists in government, industry, and academia; water managers; regulators; elected officials; and watershed groups and others in the general public. The audience spans technical and "non-technical" capabilities (defined as those who may not be formally trained in hydrologic sciences). It includes traditional USGS stakeholders or cooperators, such as natural resource managers, academia, and the engineering community, as well as more non-traditional stakeholders, such as those in the health and recreation fields and those in policy-making roles. broad audience, including elected officials and other policy makers, managers, regulators, academia, and planners. General categories include:

- Federal, State, and local natural resource managers, regulators, and planners with routine governmental responsibilities for planning and public decisions within regulatory, natural resource, transportation, planning, and health agencies.
- Public-water utilities and other water practitioners.

- Representatives of non-governmental organizations (NGOs) (professional societies, trade associations, and public-interest organizations) and legislatures with significant interests in the environment, natural resources, drinking water, transportation, planning, and recreation.
- Science and engineering community, including academia, consulting, and industry.

Partnerships

1. U.S. Environmental Protection Agency—The U.S. Environmental Protection Agency (EPA) uses nationally consistent NAWQA data to support their efforts related to performance measures, pesticide registration, unregulated contaminant listing and regulatory evaluation for drinking water (such as the Candidate Contaminant Listing and its Regulatory Determinations), aquatic health criteria and protection, development of nutrient criteria, nutrient and pesticide management plans, stream protection and restoration, source-water protection (such as related to the 1996 Amendments to the Safe Drinking Water Act), mercury emissions, fish consumption advisories, monitoring strategies, and assessments of exposure (such as related to the Food Quality Protection Act). Partnerships continue to be fostered with EPA Regional and Headquarters offices, including the Office of Pesticide Programs, Office of Wetlands, Oceans, and Watersheds, Office of Ground Water and Drinking Water, Office of Research and Development, and Office of Science and Technology. USGS will continue to provide information and foster active partnerships and collaboration with EPA on:

- Pesticide data and models considered in EPA pesticide registration, re-registration, and other regulatory decisions,
- Development of aquatic-life benchmarks and water-quality indicators;
- Nutrient data considered in EPA development of nutrient criteria and indicators;
- Water-quality benchmarks, including health-based screening levels (HBSLs), for unregulated contaminants;
- Model and develop predictions of contaminant concentrations and ecological conditions in unmonitored areas;
- Data collection, national monitoring designs, and strategies;
- Ancillary data like the National Hydrography Data set (NHD Plus), Water-Body Delineations (watershed delineations), and other data sets related to land use and hydrology which are needed to interpret monitoring data and build predictive models;
- Consultation on source-water quality assessments; and
- Exchange of technical information and technology transfer on analytical methods and monitoring methods and protocol development.

USGS will continue to work with EPA and States on the integration of NAWQA long-term data on hydrologic, chemical, and stream ecological conditions with spatially extensive, statistical estimates such as available through State monitoring programs and the EPA Environmental Monitoring Assessment Program (EMAP), Wadeable Streams Assessment Program, and lakes and large rivers program. The integrated assessments will help to predict ecological conditions in unmonitored areas and relate changes in biological conditions to trends in concentrations of pesticides and nutrients, habitat, and hydrologic variation (such as fluctuations in streamflow).

USGS will continue to provide data to support the EPA *State of the Environment* Reports (2007 and beyond), as appropriate. For example, NAWQA national information will contribute to the development and refinement of indicators on nitrate and pesticides in streams and ground water in agricultural watersheds and on nitrogen and phosphorus discharge from large rivers.

2. The H. John Heinz III Center for Science, Economics, and the Environment (The Heinz Center)--The NAWQA Program will continue its partnership with the Heinz Center to develop and populate national indicators on nutrients (phosphorus and nitrogen), contaminants (including pesticides and other synthetic organic compounds), and flow in streams and ground water. This information is used in the development of the Heinz Center *State of the Nation's Ecosystems* Report*s*, periodically produced every 5 years and anticipated in 2007 and 2012.

3. U.S. Department of Agriculture—Partnerships will continue with the U.S. Department of Agriculture (USDA), including the Natural Resources Conservation Service (NRCS), NASS, and the Census of Agriculture, to enhance linkages between monitoring data and models with chemical use, sources of contaminants, land use, and conservation programs. In addition, NAWQA will continue to provide data and information to support the USDA Conservation Effects Assessment Project (CEAP) effort. USGS information and mass-budget approaches help to evaluate the role of hydrology and contaminant transport in evaluating the effectiveness of conservation and best-management practices on water quality in agricultural streams.

4. National Oceanic Atmospheric Administration—The NAWQA Program will continue to work with NOAA (National Ocean Service and National Centers for Coastal Ocean Science) in their efforts to protect estuarine and coastal waters by providing information on key sources, nutrient loadings, and watersheds that contribute most to the transport of contaminants to receiving waters.

5. Center for Disease Control—NAWQA will continue collaboration with the CDC and provide chemical data to support its Environmental Public Health Tracking Network and overall efforts to relate environmental factors to cancer and other diseases.

6. State agencies—Partnerships, especially through the distributed nature of USGS Cooperative Water Programs, continue to develop with water-resource managers within individual State resource agencies responsible for the development of nutrient criteria, nutrient and pesticide management programs, implementation of Total Maximum Daily Loads (TMDLs), estuarine and coastal management, source-water protection, stream protection and restoration, fish consumption advisories, ground-water management, and implementation of cost-effective monitoring strategies.

7. Drinking-water community—NAWQA continues collaboration with the drinking-water community that relies on ground water for drinking-water supply. This information helps water providers and other drinking-water practitioners, water managers, and those interested in drinking water policy to determine the vulnerability and sustainability of water resources for future supply, and to develop cost-effective ground-water monitoring programs. In addition, collaboration continues to be pursued with epidemiologists with State health agencies and with Center for Disease Control. This public health community has an expressed need for information on relations between untreated water and human health and for practical indicators linking public supplies to the incidence of disease. Partners span all levels of government and non-governmental organizations, utilities, universities, and the private sector.

8. National Water-Quality Monitoring Council—The NAWQA Program will continue collaboration and support for the National Water-Quality Monitoring Council (composed of more than 50 representatives from other Federal, State, Tribal, and local agencies, non-governmental organizations, industry, and academia) in their effort to develop consistent methodology and national water monitoring networks.

9. Academia—Collaboration will continue with various university researchers, the Academy of Natural Sciences, and the Consortium of Universities for the Advancement of Hydrologic Sciences (CUAHSI). For example, assessments on the potential effects of pesticide mixtures on aquatic organisms will continue with the Southern Illinois University Fisheries and Illinois Aquaculture Center and Department of Zoology. Assessments of the relative importance and priorities for high-production volume chemicals; source-apportionment modeling of VOCs; and continued development of health-based screening levels (HBSLs) will continue with the Oregon Health Sciences University. NAWQA will continue its cooperative agreement with the Academy of Natural Sciences for national synthesis of algal community data.

Liaison Activities and Representation in External Forums

The NAWQA Program will continue to implement and support outreach and liaison activities at local, State, regional, and national scale. In addition to the many partnerships described above outreach and liaison activities supported during the next five years, without ties to a specific geographic region or Program Element, include:

- Continued support for a National Liaison Committee, consisting of about 100 representatives with water-resources responsibilities or interests from Federal, State, and regional organizations, academia, public interest groups, professional and trade associations, and the private industry. This liaison committee meets about two times per year to 1) exchange information on findings and about water-resource issues of national and regional interest, 2) identify sources of data and information, and 3) provide feedback on any Program changes, design, and scope of products. In addition, this committee provides external reviews on prominent NAWQA documents and reports. Working groups and 1-1 collaborative efforts will continue to be developed as spin-offs from this committee to address specific issues of mutual interest, such as related to drinking water, water-quality benchmarks, and urban and agricultural issues.

- Representation on the national *Source Water Collaborative*, which is a group of 17 governmental and non-governmental organizations striving towards improved dissemination of information and tools needed to protect source water and drinking-water supplies.

- Public congressional briefings on key findings relevant to water-issues of national concern. Since 1998, the Program has co-hosted or participated in 19 congressional briefings, in large part supported by the Water Environment Federation. The NAWQA Program anticipates about two briefings per year over the next five years, addressing topics such as mercury, water quality in domestic and public-supply wells, and conditions and trends in the Nation’s waters for nutrients and stream ecology.

- Collaborative efforts with the Hypoxia Task Force and support for multi-agency efforts, such as related to the Mississippi River Basin and hypoxia in the Gulf of Mexico.

- Collaborative efforts and support for the National Water Quality Monitoring Council, including on the development of consistent methods; planning and implementation of a National Monitoring Network for Coastal Waters and their Tributaries; and dissemination of information through periodic national conferences and workshops.

- Continued participation in other scientific and water-related conferences and workshops at all levels of the Program.

A major outreach effort during the next five years will focus on detailed planning for the NAWQA vision and activities during its third cycle (2013-2022). NAWQA will build on its partnerships and liaison process and institute a rigorous chartered process to identify and seek a balance among (1) emerging and current water-resource issues, (2) policy and management challenges, (3) new and current science directions; (4) opportunities for increased collaboration with other programs and organizations, (5) new technologies, modeling, and assessment techniques, and (6) enhanced communication strategies. The planning process will be spearheaded by a "Steering Committee on Future Directions," comprised of members from the NAWQA National Leadership Team, scientists from NAWQA's different Program elements, as well as scientists and managers from other USGS programs and other organizations. The plan will support the 10-year Science Strategy of the USGS, particularly related to understanding ecosystems and predicting ecosystem change, the role of the environment and wildlife in human health, climate variability and change, and quantifying, forecasting, and securing freshwater for America's future, and being to contribute to assessments on climate variability and change from a water-quality perspective.

Expected Products and Communication Strategies

The NAWQA Program is committed to making its information, technology, and products available and responsive to partner and stakeholder needs through continued implementation of the NAWQA external communication process. This process strategically targets a wide range of stakeholders through diverse formats, and in response to specific water issues. The expected outcome is that scientific insights are integrated into everyday and emerging water-resource decisions, management, and policy that go on at all levels, and the information contributes to new perspectives and perceptions on key issues.

The Program anticipates the continued production and dissemination of technical and non-technical publications, including comprehensive summary reports (USGS Circulars) on the occurrence of nutrients in streams and ground water and aquatic ecological conditions in streams across the Nation. Additional products and outcomes include:

- A comprehensive long-term plan guiding the NAWQA vision and activities in the Program's third cycle (2013-2023) that will address relevant water-resource issues.
- Continued improvements to the NAWQA data-warehouse. Since its inception in 1999, the data-warehouse has served chemical, biological, and physical data over the Internet to all interested individuals and organizations. In 2006, for example, the data-warehouse manages 14 million records representing about 7,600 stream sites, 8,100 wells, and 2,000 different water-quality and ecological constituents.
- Readily accessible and relevant information—including data, reports, maps, support tools, and methods—on the NAWQA website (http://water.usgs.gov/nawqa/). NAWQA will continue to expand (1) user-friendly, internet-accessible graphics, data sets, maps,

tables, and interactive capabilities for extracting and displaying information; and, (2) interpretation of NAWQA data in a human-health and aquatic-health context.

- Cyber seminars, training courses, and workshops through USGS web resources and other organization's webcasting sites
- Updated bibliographies and search engines for information by topic, environmental media, and geographic area.
- Continued development of the NAWQA stakeholder database, which, in 2006, maintains contact information and water requirements for about 2,000 stakeholders. The database is used to effectively track stakeholder needs and allows specialized, user-focused and targeted information delivery.
- Collaborative "spin off" projects and cultivation of new partnerships that expands NAWQA data collection and assessments beyond the program scope. These are cultivated through the state level USGS Cooperative Water Programs.

Budget—Annual support for Outreach, including partnerships, liaison, external representation, and communication strategies is expected to remain at about $3 million.

V. Program Review

- Review plans will follow Bureau Policy for achieving and reporting on OMB and Bureau performance metrics (PART or Performance Assessment and Rating Tool), and GPRA.
- An internal review by a USGS Ad Hoc Committee made up of scientists and managers in 2004 is being used to plan, direct, and reinforce Program activities.
- A review- will be solicited by the National Academy of Sciences near the end of the planning period to ensure continued relevance and objectivity and the best use of current scientific methods and approaches in NAWQA assessments. This review will be directed toward a draft design and plan for the Program in its third cycle (2013 and beyond.).
- The relevance of NAWQA information to stakeholder needs and water-resource issues will continue to be evaluated through the national liaison process, web hits, publication requests, interviews, focus groups, and surveys. External feedback will be integrated into Program objectives, products, and the communication process. Resulting Program changes will be communicated back to stakeholders.

VI. Expertise and Capabilities

In addition to the high levels of expertise and experience represented by the hundreds of scientists and hydrologic technicians assigned to the NAWQA Program across the U.S., the NAWQA Program will continue to rely on the National Water Quality Laboratory (NWQL) for expertise in analyzing chemical and aquatic ecological samples. The Methods Research and Development Group, which is sustained at the NWQL, will continue to provide methods for analysis of pesticides, pharmaceuticals, personal care products, and hormones. The Program also will continue to work cooperatively with the Philadelphia Academy of Natural Sciences for analysis and interpretation of algal community data. The Program will continue to work with the Oregon Health Sciences University on information needs and research directions for high – production volume chemicals and assisting the Program with placing its data in a human-health context, and with the University of Wisconsin Mercury Laboratory on mercury cycling and transformations.

VII. Facilities

The vast majority of the NAWQA Program is implemented in Water Science Centers throughout the lower 48 contiguous states. The National and Regional USGS Centers also host a number of management, technical support, and research personnel.