EPA United States Environmental Protection Agency

Drinking Water Research Program Multi-Year Plan 2003

Office of Research and Development
U.S. Environmental Protection Agency

Not Yet Externally Peer Reviewed

The Office of Research and Development's (ORD) multi-year plans (MYPs) present ORD's proposed research (assuming constant funding) in a variety of areas over the next 5-8 years. The MYPs serve three principal purposes: to describe where our research programs are going, to present the significant outputs of the research, and to communicate our research plans within ORD and with others. Multi-year planning permits ORD to consider the strategic directions of the Agency and how research can evolve to best contribute to the Agency's mission of protecting human health and the environment.

MYPs are considered to be "living documents." ORD intends to update the MYPs on a regular basis to reflect the current state of the science, resource availability, and Agency priorities. ORD will update or modify future performance information contained within this planning document as needed. These documents will also be submitted for external peer review.

DRINKING WATER MULTI-YEAR PLAN
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1. INTRODUCTION

1.1 Overview of the Multi-Year Plan

This Multi-Year Plan (MYP) describes the U.S. Environmental Protection Agency's (EPA) drinking water research program activities and plans for fiscal years 2003 - 2010. Developed by the EPA Office of Research and Development (ORD) in partnership with the Office of Water (OW), the MYP provides a link between the annual plans that support EPA's budget request and the strategic plans developed by the Agency and ORD. As a tool for planning and communication, the MYP provides: (1) a context for annual planning decisions and a basis for describing the impacts of these decisions; (2) a framework for integrating research on common issues across the ORD laboratories and centers, as well as across the various Agency Goals established under the Government Performance and Results Act (GPRA); and (3) a resource for communicating research plans and products within ORD and with EPA programs, the regions and interested parties outside of EPA.

It is recognized that research is an iterative process for which the results are not certain until the work is completed. Research findings may identify additional needs or provide new tools that can be used to pursue other lines of inquiry that may not have been anticipated or possible when the original research was planned. In addition, unexpected changes may occur in available resources or strategic priorities. For these reasons, MYPs are updated on a biennial basis to provide opportunities for making the necessary adjustments to the research program.

1.2 Drinking Water Concerns and the Safe Drinking Water Act

The provision of safe drinking water is based upon the multi-barrier concept; that is, selecting the best available source and protecting it from contamination, using water treatment to control contaminants, and preventing water quality deterioration in the distribution system. Although such practices in the U.S. have resulted in the virtual elimination of waterborne threats such as typhoid and cholera, some public health concerns remain. The continued occurrence of waterborne disease outbreaks demonstrates that the safety of drinking water may be threatened by pathogenic microorganisms if treatment is inadequate or if the quality of water in the distribution system is compromised.

Concerns have also been raised about chemical contaminants in our drinking water supply. Surface water and ground water sources may be contaminated with many different natural (e.g.,

arsenic) and man-made (e.g., pesticides) substances that could pose a risk. The disinfection process itself leads to the formation of a number of potentially toxic organic and inorganic chemical by-products. Some subpopulations, such as infants and children or those with weakened immune systems, are known to be particularly sensitive to the effects of certain waterborne pathogens and chemicals. Finally, there is a heightened awareness that water supply systems may be vulnerable to deliberate threats that could damage water supply infrastructure, or lead to contamination of source or treated water with biological or chemical agents.[3]

The Safe Drinking Water Act (SDWA) requires EPA to set national drinking water standards to ensure the safety of water consumed by the millions of people in the U.S. who receive their water from public water systems. Under the 1996 Amendments to SDWA, EPA is directed to use a risk-based standard-setting process and sound science in fulfilling the requirements of the Act. In addition to establishing timelines for regulatory actions, the Amendments include important provisions on such issues as support for small water supply systems, source water protection, public right-to-know, health risk reduction benefit analyses and water system infrastructure assistance. The Amendments contain specific requirements for research on waterborne pathogens (e.g., *Cryptosporidium* and Norwalk virus), disinfection byproducts (DBPs), arsenic, and other harmful substances in drinking water. EPA is also directed to conduct studies to identify and characterize groups that may be at greater risk than the general population following exposure to contaminants in drinking water.

The SDWA regulatory requirements with the most significant implications for drinking water research include the Microbial/Disinfection Byproduct (M/DBP) set of rules, the arsenic rule, and future decisions on unregulated waterborne pathogens and chemicals on the Contaminant Candidate List (CCL). Source water protection is a SDWA priority for which important research needs exist, and concerns about the quality of water in the distribution system raise another high priority set of needs. There are also research needs associated with a subset of the contaminants subject to the Six-Year Review requirement for all established National Primary Drinking Water Regulations. A brief description of these rules and statutory provisions is found in Appendix A.

2. EPA's DRINKING WATER RESEARCH PROGRAM

2.1 Scope, Organization, and Budget

In response to the SDWA requirements, ORD has established an integrated, multidisciplinary research program that is closely linked to OW's regulatory activities and timelines. The broad scope of ORD's research includes the development of new scientific data, innovative methods

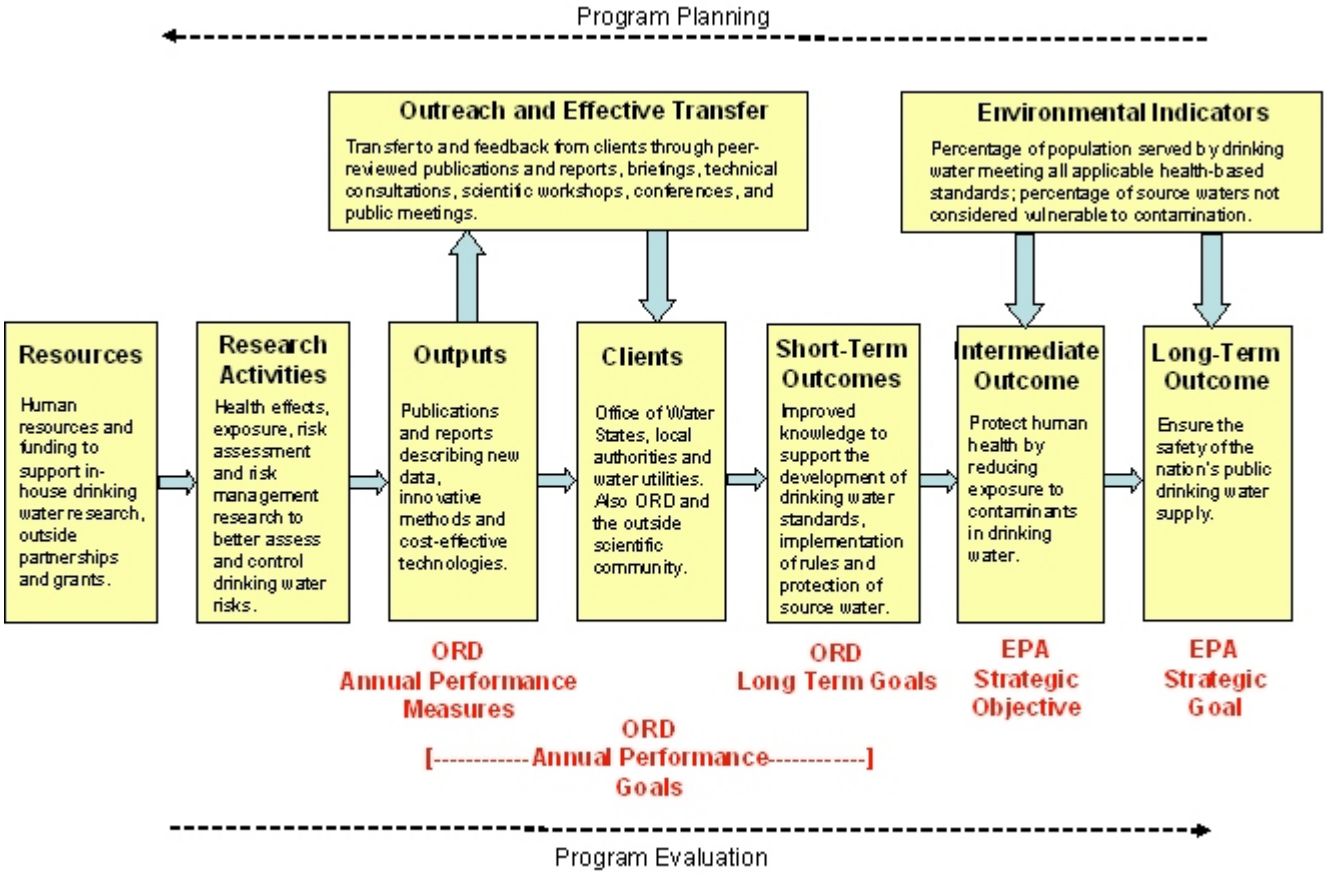
[3]Water security research is described in a separate planning document that is being developed jointly by OW's Water Protection Task Force and ORD's National Homeland Security Center.

and cost-effective technologies for improving the assessment and control of drinking water risks. The research products and technical assistance provided by ORD scientists support both OW decision making and the implementation of EPA rules and guidance by the states, local authorities and water utilities. Within ORD, this research is the responsibility of five national laboratories and centers: the National Exposure Research Laboratory (NERL), the National Health and Environmental Effects Research Laboratory (NHEERL), the National Risk Management Research Laboratory (NRMRL), the National Center for Environmental Assessment (NCEA), and the National Center for Environmental Research (NCER).

The level of resources for drinking water research in FY03 is approximately $50M and 232 full-time equivalent (FTE) personnel. The research program described in this MYP has been developed with the assumption that the resources available for drinking water research over the period covered by the MYP will remain constant.

2.2 Drinking Water Research Program Logic Model

The design of the drinking water research program is based on the application of the research program logic model, shown below. This model describes the components of the drinking water



Drinking Water Research Program Design Logic Model

program and the sequence of activities that lead to the accomplishment of desired outcomes. The process of designing the research program begins at the right side of the figure and moves toward the left (in the "Program Planning" direction). The first steps involve a consideration of the Agency's long-term, intermediate and short-term outcomes for drinking water, which are derived from Goal 2 of EPA's Strategic Plan. These outcomes and the key science questions relating to the assessment and control of waterborne contaminants then provide a context for ORD's Long-Term Goals (short-term outcomes), Annual Performance Goals (outputs of the research program, defined in the context of the desired outcomes), and Annual Performance Measures (scientific outputs that contribute to the accomplishment of the annual goals). Moving in the figure from left to right (in the "Program Evaluation" direction) illustrates the linkages between resources, research activities and outputs, clients and outcomes. The logic model highlights the importance of effective outreach and transfer of scientific and technical products to clients. Another important feature is the use of environmental indicators, also from the EPA Strategic Plan, to measure the success in achieving the intended outcomes.

2.3 Relationship to Other EPA Plans and Programs

ORD's drinking water research program supports GPRA Goal 2, "Clean and Safe Water," of the Agency's new draft Strategic Plan. As shown in Box 1, EPA's strategy for assuring safe drinking water includes four key elements. ORD is directly aligned with this strategy through its program of leading-edge, problem-driven research that supports the development or revision of standards for contaminants of concern, the effective implementation of these standards, and the protection of drinking water sources.

Box 1
EPA Strategy for Assuring Safe Drinking Water

- Develop or revise drinking water standards to assure safe drinking water
- Support states and water systems in effective implementation of standards
- Protect sources of drinking water from contamination
- Develop sustainable management of drinking water infrastructure

The drinking water research program is guided by the ORD Strategic Plan (EPA, 2001), this MYP, and the Agency's drinking water research plans for arsenic (EPA, 1998a) and Microbes/Disinfection Byproducts (EPA, 1997). Additional guidance is obtained through internal program reviews, expert workshops on special topics, and consultations with advisory groups, research organizations and other federal agencies.

Research being conducted under other ORD research programs is helping to address some important drinking water concerns. The Human Health MYP includes research relating to sensitive subpopulations and improving the scientific basis for risk assessments. Research on source water protection issues, such as best management practices, the development of diagnostic

tools and studies of pharmaceuticals/personal care products, is part of the Water Quality MYP. Related water quality research is also described in the Ecological Research MYP. The Endocrine Disruptors MYP describes ORD's program to provide new data and methods to help assess and manage these types of chemicals in the environment. Finally, an important component of ORD's research in the Pollution Prevention MYP is the Environmental Technology Verification (ETV) Program, which is designed to verify the performance of improved treatment technologies developed by the private sector. The ETV's Drinking Water Systems Center was established in 2000 to provide independent verifications of drinking water technologies.

2.4 ORD's Position in the Research Community

ORD has long been a leader in the field of drinking water research, with unique capabilities for solving the broad range of scientific and technical issues faced by OW. No other organization's overall mission and drinking water research plans so directly support the Agency's regulatory needs. Several public and private organizations, most notably the American Water Works Association Research Foundation, the Centers for Disease Control and Prevention, the National Institute for Environmental Health Sciences, and the U.S. Geological Survey, collectively conduct or support millions of dollars of drinking water research annually. Partnerships with these organizations provide a means of leveraging resources and ensuring the coordination of research. EPA recently established a cooperative agreement with the Global Water Research Coalition (GWRC), which is comprised of 12 of the most prominent national water and wastewater research groups in the world. The principal purpose of the GWRC is to provide a forum for leveraging funding and expertise among the participating organizations, and fostering a coordinated approach to water research on common issues of concern.

In addition to its interactions with the research community, ORD plays an active role in providing technical assistance to states, local authorities, utilities and others in the drinking water community. For example, simplified technology resource guides are routinely developed and shared with the National Rural Water Association to help small utilities. ORD scientists work with the Association of State Drinking Water Administrators on a variety of issues, such as the identification of host sites for arsenic treatment technology demonstration projects.

2.5 Progress to Date

In FY 2001 and 2002, considerable progress was made toward meeting some of the major goals of the drinking water research program. Accomplishments include:

Arsenic

- A guidance document on small system arsenic removal is assisting communities in the implementation of the new drinking water standard for arsenic.
- Research findings from laboratory and field studies have provided new data on the health effects of arsenic.

Disinfection Byproducts

- New information was developed to assess exposures and health risks for several well known DBPs of potential concern.
- A report was produced on approaches for designing DBP mixture studies and assessing risks.
- Methods were developed for integrating multi-route exposures and dose-response data to evaluate the risk of complex mixtures of drinking water contaminants.
- Some of the remaining implementation issues for DBPs were addressed in studies of technologies for reducing levels of byproducts in finished water. Approaches investigated included enhanced softening to remove DBP precursors and enhanced coagulation to control DBPs in the treatment plant.

Cryptosporidium and Waterborne Disease Outbreaks

- Improved methods were developed for detecting *Cryptosporidium* and for optimizing the control of this pathogen through treatment.
- Scientists from EPA and CDC collaborated to produce the biennial report on the occurrence of waterborne disease in the U.S.

Chemicals and Pathogens on the Contaminant Candidate List

- Formal risk assessments were completed for several CCL chemicals
- Improved analytical methods were developed for detecting various CCL chemicals and pathogens

3. IDENTIFICATION OF KEY SCIENCE QUESTIONS

The key science questions for drinking water correspond to the areas of greatest uncertainty in the assessment and control of drinking water risks. The research that is needed to address these questions depends upon the type of contaminant, the strength of the underlying data base, and the ultimate use of the new information by a decision maker. For certain waterborne pathogens or chemicals, basic analytical detection methods may be inadequate for conducting national occurrence studies, and the health effects data base may be insufficient for characterizing the potential hazard. The ability of conventional treatment technologies to remove or inactivate the contaminant may be unknown. More specialized research studies of individual contaminants or mixtures may be necessary to better evaluate the mode of action, the risk posed by drinking water exposures versus other exposure routes, or the effectiveness of advanced treatment technologies. New data, improved methods and technologies are often needed to support the establishment of Maximum Contaminant Level Goals (MCLGs), Maximum Contaminant Levels (MCLs), and treatment technique requirements for contaminants of concern. Research findings can also play an important role in evaluating the benefits of various regulatory options.

In general, the research needs for contaminants that are already regulated are highly focused on the remaining critical uncertainties in the assessment or management of the risks. For unregulated contaminants, the needs may initially be more broad if the underlying scientific data base is less developed. Chemicals or pathogens on a track toward regulation typically require a more robust scientific data base than those for which a decision to not regulate will be made.

The important scientific questions for each of the major components of the drinking water research program are identified in the following sections.

3.1 Arsenic Rule

New scientific data and assessments by EPA and outside scientists in recent years provided a basis for lowering of the drinking water standard for arsenic from 50 to 10 µg/liter in 2001. The most important remaining scientific issues relate to aspects of the implementation of this new rule and the required regulatory review that occurs in six-year cycles. The key scientific questions for arsenic are:

(1) What are the most cost-effective technologies for removing arsenic from drinking water and managing residual wastes, particularly for small systems? What is the significance of arsenic accumulation in the distribution system?

(2) How can the quantitative assessment of the relationship between exposure at low doses (in the 10 µg/liter range) and the risk of cancer or noncancer effects in susceptible populations be strengthened?

3.2 M/DBP Rules

The M/DBP rules are an interrelated set of regulations designed to provide public health protection against waterborne pathogens (Surface Water and Ground Water rules) while minimizing the risks posed by exposure to DBPs (Stage 1 and 2 DBP rules). Scientists from EPA and other research groups have made important contributions to the establishment of the M/DBP rules. A number of research issues still need to be addressed to support the implementation of the rules and to improve the scientific basis for future regulatory reviews as required by SDWA. The most important outstanding scientific questions for these rules include:

Waterborne Pathogens

(1) How can analytical methods to detect Cryptosporidium in water matrices be improved?

(2) What data and methods are needed for assessing the risks associated with exposure to protozoa and viruses in source water and ground water?

(3) How can treatment be optimized to remove/inactivate Cryptosporidium, particularly for small systems? How can these approaches be balanced to also control DBPs?

Disinfection Byproducts

(1) How can the health effects (especially adverse reproductive outcomes) of the highest priority byproducts and DBP mixtures be better characterized?

(2) What is the risk posed by exposure to the byproducts that are formed: (a) from the use of alternative disinfectants (i.e., other than chlorine alone), and (b) as a consequence of differences in source water quality (e.g., sources with high versus low bromide concentrations)?

(3) What analytical methods, occurrence data and methods for estimating DBP formation are needed for determining exposures to byproducts of concern?

3.3 Six-Year Review of NPDWRs (1996-2002 Review Cycle)

The outstanding scientific questions associated with this part of the research program are contaminant-specific. EPA conducted a research needs analysis as part of the systematic review of most of the National Primary Drinking Water Regulations (NPDWRs) that were published prior to the 1996 SDWA Amendments. This analysis led to the identification of data gaps or assessment needs for chromium, fluoride and lead/copper. To address these needs, the National Toxicology Program is performing research on the health effects of chromium, and the National Academy of Sciences is conducting an assessment of recently published health effects data on fluoride. EPA is further evaluating the treatment and monitoring issues identified for lead/copper. The Agency is also considering comments from some stakeholders concerning the need for health effects and treatment research on antimony. Additional needs in the areas of health effects, treatment, analytical methods, occurrence and/or exposure may be identified in future reviews of NPDWRs.

3.4 Unregulated Contaminants (CCL) and Future Rules

The research issues for the unregulated contaminants presents some of the biggest challenges to the drinking water research program, along with perhaps the greatest opportunities for advancing the science. The existence of many thousands of unregulated chemicals and microbes that may contaminate water at the source highlights the need to focus scientific efforts on those that may pose the greatest public health risk. The large number of substances with a highly variable underlying scientific data base also necessitates the development of new approaches for prioritizing, assessing and managing these contaminants. There are two general scientific questions relating to the CCL unregulated contaminant program:

(1) What contaminant-specific research is needed to address key data gaps for high priority waterborne pathogens and chemicals that are or could be listed on the CCL? The process of identifying and prioritizing contaminant-specific research involves a two-phased approach that considers the needs for screening level and more detailed risk assessment/risk management analyses. Research needs may relate to analytical methods or exposure issues, health effects data for endpoints of concern, risk assessments and/or treatment technologies. The specific scientific questions, therefore, will vary depending upon the particular contaminant of interest and the phase of the risk assessment/risk management process.

(2) What innovative approaches can be developed for identifying and prioritizing contaminants for listing on the CCL, as well as for assessing and managing risks? Research needs in this area stem in part from the issues raised by the National Research Council in their report entitled "*Classifying Drinking Water Contaminants for Regulatory Consideration"* (NRC, 2001). The primary focus of this report was on approaches for narrowing the broad universe of potential waterborne pathogens and chemicals into a smaller, more focused list of contaminants that should be included on future CCLs.

3.5 Source Water Protection

The key scientific questions for source water protection fall into the following categories: (a) water quality criteria; (b) source water assessments; (c) preventative measures to address sources of contamination; and (d) contingency planning. A range of scientific issues exists within each of these categories. Some of the most important questions include:

(1) How adequately do the Ambient Water Quality Criteria (AWQC) that address the major drinking water contaminants protect public health?

(2) What improved techniques are needed to better define source water characteristics and sources of contamination?

(3) What are the fate and transport characteristics of certain types of contaminants in surface water and ground water?

(4) How effective are candidate protection measures (i.e., Best Management Practices) on improving the quality of the source water?

(5) What is the impact of sudden increases in source water contaminant concentrations on drinking water treatment performance?

(6) What early warning and monitoring systems should be developed to alert utility operators of contaminant excursions at the source so that corrective actions might be employed?

Efforts are currently underway within EPA to further identify and prioritize the research needs as they relate to these questions. This will help to further strengthen linkages between the SDWA-oriented drinking water research program and the Clean Water Act-based water quality research program within ORD.

3.6 Distribution Systems

Deterioration of the quality of water in the distribution system is increasingly being recognized as a potentially important public health concern. Some of the factors that can affect water quality in distribution systems include the intrusion of contamination due to pressure transients, cross-connections, growth and survival of pathogens in biofilms, and deterioration of the structural integrity of aging systems across the country. Contamination entering the distribution system has been responsible for a significant percentage of the waterborne disease outbreaks reported in recent years. These problems raise a number of important scientific questions, as identified below:

(1) What are the public health risks associated with contamination of the distribution system?

(2) How can the structural and operational failure modes that reduce water quality in the distribution system be characterized?

(3) What new or improved methods are needed to prevent, detect, locate, repair, and rehabilitate contaminant intrusion points in water distribution systems?

(4) What new or improved methods are needed to monitor and control internal distribution system conditions that may result in the deterioration of water quality?

4. LONG-TERM GOALS

4.1 Overview

The MYP has three Long-Term Goals (LTGs), as shown in Box 2. The LTGs address the need for new scientific knowledge, tools and technologies to support more sound decision making in three distinct areas of the drinking water regulatory program:

- Regulated contaminants (LTG 1)
- Unregulated contaminants, as well as innovative approaches and new data to support future decision making (LTG 2)
- Source water protection and distribution systems (LTG 3)

Research to accomplish the LTGs seeks to improve the scientific foundation for identifying and assessing the risk associated with exposure to contaminants of potential concern. The research is also intended to help states, local authorities and utilities to implement EPA rules in the coming

Box 2
Long-Term Goals

LTG 1. By 2010, develop scientifically sound data and approaches to assess and manage risks to human health posed by exposure to regulated waterborne pathogens and chemicals, including those addressed by the Arsenic, M/DBP, and Six-Year Review Rules.

LTG 2. By 2010, develop new data, innovative tools and improved technologies to support decision making by the Office of Water on the Contaminant Candidate List and other regulatory issues, and implementation of rules by states, local authorities and water utilities.

LTG 3. By 2009, provide data, tools and technologies to support management decisions by the Office of Water, state, local authorities and utilities to protect source water and the quality of water in the distribution system.

years by providing new information on how to better protect source waters, optimize treatments for the control of targeted contaminants, and improve the quality of water in the distribution system. Accomplishing these LTGs will play a vital role in helping the Agency meet its strategic goal of ensuring the safety of the nation's public drinking water supply.

4.2 Changes in Emphasis of the LTGs

The relative level of scientific effort and corresponding resources for each of the LTGs is expected to change according to the trends shown in Box 3. As a general trend, the level of effort devoted to further refining the underlying science supporting the existing rules covered by LTG 1 (e.g., arsenic treatment technology research) will be reduced as progress is made in the coming years. Continued efforts will be needed for the existing rules in some areas to address the outstanding scientific issues that will be the focus of future regulatory reviews. LTG 2 represents an increasingly important part of the drinking water research program,

Box 3
Changes in Emphasis of the LTGs (FY 2003 - 2010)

LTG	Emphasis
1	Decreasing
2	Level, then possibly increasing
3	Level, then possibly increasing

as it includes research on unregulated contaminants that may be candidates for future regulatory decisions. It also includes the development of new data and innovative approaches for other decision making activities. Finally, as new focus areas in LTG 3 of the MYP, source water protection and distribution system research will stay level in the near-term. The level of effort may increase in the future because of the many scientific challenges in these areas.

4.3 Description of the Flow Diagrams and Tables

Accomplishment of the LTGs is dependent upon the successful completion of a series of associated Annual Performance Goals (APGs). APGs are major research outputs that are described in the context of the outcome to which they contribute. They represent significant milestones along a critical path toward accomplishment of the LTG. The APGs are in turn achieved through the completion of a set of Annual Performance Measures (APMs). APMs are defined as ORD research outputs that contribute to the accomplishment of an APG by addressing the most important scientific issues for that particular performance goal.

Figures 1-3 show the relationships between the APGs for each of the drinking water research program's LTGs. The APGs address the scientific questions described in Section 3, and have a distinct programmatic orientation in terms of timing over the period of FY 2003 - 2010. The designation of a fiscal year for a particular APG is based on a projection of critical points in the development of the science, plus a consideration of when scientific information is needed to support important regulatory milestones relating to the development, review or implementation of the rules. It is acknowledged that scientific discovery cannot always be timed to produce information by designated dates. Nevertheless, the planning of the drinking water research program in this manner serves to focus the research and enhance ORD's responsiveness to the needs of OW and to outside clients.

Tables 1-3 show the APGs and APMs for each LTG. As indicated in the tables, a number of the APMs address more than one APG. The following discussion provides an overview of the performance goals and measures, with highlights of some of the important ORD products that will be produced.

4.3.1 APGs and APMs in LTG 1 (Figure 1, Table 1). The APGs and APMs for arsenic address the scientific questions pertaining to the implementation of the current rule and the reviews of the rule in 2006 and 2012 (see Section 3.1). The implementation-related APGs in FY 2004 and 2006 are along a critical path that will provide information and technologies to help states, local authorities and water utilities meet the 2006 deadline for complying with the new rule. The two remaining arsenic APGs in FY 2006 and 2010 support the SDWA-required review of the rule by focusing on research to improve the arsenic risk assessment. APMs under these APGs represent a progression of studies in animals and in human populations, providing OW with new information on exposure to arsenic and on its metabolism, mode of action and health

effects. Achievement of the FY 2006 APG will involve the preparation of a synthesis document that summarizes these new findings and identifies research that may further strengthen the arsenic risk assessment that will support the next six-year review of the rule.

DBP research to address the scientific questions in Section 3.2 is represented by APGs in FY 2004, 2007, and 2010. The primary emphasis of these APGs and supporting APMs is to provide data on the most important unresolved issues in the DBP risk assessment, in anticipation of the review of the Stage 2 DBP rule in 2011. APMs include research to better characterize the reproductive toxicity and carcinogenicity of individual DBPs and mixtures of byproducts (including an innovative cross-ORD complex mixture study), epidemiology studies to evaluate DBP reproductive risks, and analytical chemistry studies to identify previously uncharacterized byproducts associated with the use of alternative disinfectants. The FY 2007 APG, which includes the delivery of a synthesis document on reproductive outcomes and DBPs, represents a particularly important milestone along the path of understanding the potential risks associated with exposure to DBPs. Many of the health effects, exposure and risk assessment studies that are being conducted or planned in support of the APGs in FY 2004, 2007 and 2010 represent a progression of research that builds upon the earlier accomplishments to further the science.

The FY 2004 APG also has a relatively small emphasis on research to support the implementation of the current Stage 1 DBP rule and the new Stage 2 rule proposed in 2003. This APG includes APMs on the formation, occurrence and detection of DBPs of particular concern.

Microbial research addressing the key scientific questions relating to the Surface Water and Ground Water Rules (see Section 3.2) is covered by APGs in FY 2004, 2006, and 2009. APMs supporting the implementation of these rules include the development of improved analytical detection methods for *Cryptosporidium* and viruses, and the evaluation of various water treatment technologies for removing *Cryptosporidium* from water (particularly for small systems). Other APMs describe efforts that will contribute to future reviews of the rules to determine if additional requirements may be necessary to afford greater protection against microbial risks. This research includes studies of human exposure to waterborne pathogens and the development of improved methods to assess microbial risks. Data on the infectious dose and other properties of *Cryptosporidium*, along with new information on waterborne disease in the U.S., will provide a better understanding of the risks posed by pathogens in drinking water as a function of water source, type of treatment and etiologic agent.

Finally, there are two APGs in LTG 1 that pertain to the Six-Year Review of the National Primary Drinking Water Regulations. These APGs are not arrayed along a critical path at this time, as they represent distinct sets of research projects to address specific needs for a few contaminants. The overall level of effort devoted to these studies is relatively small, and planning decisions involve a careful consideration of the needs and benefits of investing ORD resources on these issues. The APMs under the FY 2005 and 2008 APGs are comprised of

studies in the areas of chemistry, treatment or risk assessment to address high priority needs for chromium, lead/copper, fluoride, nitrate, antimony, and other contaminants to be determined (Section 3.3).

4.3.2 APGs and APMs in LTG 2 (Figure 2, Table 2). The CCL-related APGs in FY 2003, 2005, 2007, and 2010 support OW's listing decisions and regulatory determinations on specific unregulated waterborne contaminants. The APGs represent a progression of outcomes supported by research activities that provide the necessary scientific information and tools for moving listed contaminants in the direction toward a regulatory determination and to support promulgation of the regulations. To accomplish these goals, ORD has placed a major emphasis on the development of new data and methods for selected high priority pathogens and chemicals on the CCL. As noted in Section 3.4, the research needs are contaminant-specific and are addressed using a phased approach. In this manner, ORD will provide OW with the type of information needed to support decision making at various steps in the CCL process.

Research in the areas of exposure, health effects, risk assessment and risk management is being conducted on many of the same CCL contaminants. APMs for pathogens in LTG 2 include reports on improved analytical methods and occurrence data for priority agents such as *Mycobacterium*, *Helicobacter* and microsporidia. Health effects research includes studies on *Mycobacterium*, microsporidia and cyanobacterial toxins, and risk assessments for some of these and other CCL pathogens are being conducted or planned. Risk management research includes studies to evaluate the ability of conventional and alternative treatment technologies to inactivate or remove many of the listed pathogens. CCL chemical research emphasizes the development of improved analytical methods and occurrence data, along with treatability and distribution system studies. Health effects and risk assessment research includes toxicity, mode of action and pharmacokinetic studies to improve the risk assessments for chemicals such as MTBE and organotins.

"Innovative methods" APGs in FY 2005, 2007, and 2010 address the need for new data, tools and technologies that will significantly advance the science of assessing and controlling drinking water risks (see Section 3.4). This research is designed to support the CCL program, as well as other areas where innovative approaches are needed to support decision making at the national, state and local level. A focused effort will be made in the next two years to further refine this part of the MYP, as the process for using these new tools and information has not yet been fully determined.

Research products supporting the FY 2005 and 2007 APGs explore the use of a number of different approaches for identifying, characterizing, and prioritizing contaminants for further analysis or listing on the CCL. Examples include APMs that describe the use of quantitative structure-activity relationships (QSARs) for predicting health effects, and the use of computational and genomic/proteomic approaches to better understand the mode of action of

contaminants of potential concern. DNA microarrays are being developed for detecting multiple pathogens in water, and virulence activity factors are being evaluated for their usefulness in characterizing CCL pathogens. Risk management research includes studies to evaluate alternative strategies for compliance with drinking water regulations, and studies of approaches for dealing with the emerging issue of indirect drinking water reuse. The FY 2010 APG includes research that builds upon the accomplishments of the prior-year APGs. This goal has a particular focus on the development of new data for more robust risk assessments, considering cumulative risks and aggregate exposures. A synthesis report will be produced on the use of mixtures risk assessment approaches to inform drinking water regulatory decisions. The APG also includes research to evaluate the benefits of risk management decisions for drinking water.

4.3.3 APGs and APMs in LTG 3 (Figure 3, Table 3). The scientific questions associated with source water protection and distribution systems (see Sections 3.5 and 3.6) encompass a broad range of issues. As mentioned in Section 2.2, source water protection is also a component of other ORD research programs, although the protection of drinking water quality may not be their primary goal. The water industry has an active research program in source water protection and distribution systems. ORD's drinking water research program is therefore focused on areas that are not being fully addressed by other means and that match ORD's technical capabilities.

APGs for source water protection in FY 2006 and 2009 are designed to assist decision makers at the national, state and local level by providing tools and information that contribute to more effective management practices. Research supporting these APGs is distinguished from related research in the Water Quality MYP by virtue of its focus on protecting the quality of water used as a drinking water source. APMs include reports that describe how to better assess the vulnerability of watersheds, how to detect specific contaminants and other changes in water quality using improved diagnostic tools, and how to more effectively manage different types of contamination problems. The APGs for distribution systems in FY 2006 and 2008 will be accomplished by providing new information and tools for characterizing and managing distribution contamination problems. Examples of the types of issues being investigated by ORD include biofilm formation and control, detection methods for monitoring selected water quality parameters and system structural integrity, and the contamination of distribution systems with organotins and opportunistic pathogens on the CCL.

4.4 Potential Additional Work

The topic areas listed below have been identified as possible candidates for funding if additional resources above the base become available. These areas represent logical extensions of activities that are being conducted or planned in the base program. The enhanced level of research in these areas would, in general, further strengthen ORD's ability to address the existing LTGs in this plan. The priority and resource requirements for these topics have not been determined.

- Source water assessment and protection, with a focus on such areas as reducing impacts of septic systems and other non-point sources, wet weather flow and the development of real-time monitoring systems.

- Expansion of the new program on molecular technologies for screening, prioritizing and monitoring contaminants of concern. This would have applications for risk assessment (e.g., to support hazard evaluations), risk management (e.g., to monitor water sources, treatment plants and distribution systems), and research planning in general.

- Contaminant mixtures research in the areas of health effects, exposure/methods, risk assessment and prevention/treatment to support risk management decisions. This could include, for example, studies of mixtures of DBPs, endocrine disruptors or CCL chemicals that occur together in drinking water.

- Research to support assessments of aggregate exposures and cumulative risks for specific drinking water contaminants to determine relative source contributions and to support health risk reduction/risk benefit analyses. This research would address exposure and risk issues associated with oral, inhalation (e.g., from showering, cooking) and dermal (e.g., from showering, swimming) exposures to chemicals in drinking water. The impact of episodic vs. chronic exposures on risk would also be addressed.

- Assessment of human exposure and health impacts of distribution systems. This includes an evaluation of the prime causes of health risks (e.g., structural failures, cross-connections, biofilms)

- Social science research on drinking water issues (e.g., to support cost/benefit analyses). This would be a new line of research in ORD's drinking water program.

5. CHANGES FROM PREVIOUS MYPs

Several major changes were made to the MYP this year. The drinking water research program is now described in terms of three LTGs instead of one, which better represents both the scientific and programmatic dimensions of the research program. Of particular note is the introduction of a new area of emphasis in one of the LTGs: innovative approaches for identifying, prioritizing and managing contaminants of concern. In addition, research on source water protection and distribution systems is described in a separate LTG, which places a greater focus on these important issues in the plan. In general, the relative level of research activity and resources in the various areas across the program are approximately the same as what was described in the previous MYP, although the new plan reflects an enhanced effort on arsenic implementation issues through 2006.

A new feature of this MYP is that it identifies several "synthesis documents" (Box 4) that provide a means of more effectively communicating the results of certain research activities to clients. These documents summarize the results of a body of ORD research on a particular topic, highlighting the importance of this research in advancing the science and meeting performance goals. The synthesis document may also provide an analysis of research needs and priorities to support outyear goals.

Box 4
Synthesis Documents in the MYP

- Synthesis document on small drinking water systems: State of the industry and treatment technologies to meet Safe Drinking Water Act requirements (FY 2005)
- Synthesis document on the health effects of arsenic and research needs to improve human health risk assessment in U.S. populations (FY 2006)
- Synthesis document on reproductive outcomes and exposure to disinfection byproducts (FY 2007)
- Integrated disinfection byproduct mixtures research - Synthesis of toxicological data (cancer, reproductive/ developmental, other noncancer effects) from the Four-Lab Study (FY 2007)
- Summary document on the utility of computational modeling (QSARs), genetox assays (microcomet), toxicokinetics, and alternative animal models to predict health outcomes (FY 2007)
- Synthesis document on the management and control of water quality in distribution systems (FY 2008)
- Synthesis document on the use of mixtures risk assessment approaches to inform drinking water regulatory decisions (FY 2009)

6. COMMUNICATION

Effective communication of ORD research plans and products with clients is essential for ensuring that the research program is responsive to client needs and effective in achieving the intended outcomes of the research. ORD and OW have an exceptionally close working relationship, characterized by frequent consultations, briefings and joint planning meetings. A series of APG-oriented topic area discussions involving ORD and OW scientists and managers has been initiated. The goal of these meetings is to review the underlying science for a particular topic area in the MYP, discuss research priorities, and examine ORD research outputs in the MYP to see how well the research matches the needs.

As described in the previous chapter, the MYP identifies several synthesis products that are intended to provide an effective means of transferring ORD's scientific products to OW and other clients. In addition, an internet-based drinking water research tracking system is being developed as a tool to be used by internal management and staff, as well as by external clients, for reviewing the status of current projects supporting APMs in the MYP. Many of the near-term APMs (generally FY2003 - 2006) in Tables 1-3 of the MYP have hotlinks to project descriptions that reside within this data base. A fully operational tracking system will be available to the public in 2004.

7. REFERENCES

EPA, 1997. *Research Plan for Microbial Pathogens and Disinfection By-Products in Drinking Water*. EPA 600-R-97-122, Office of Research and Development, U.S. EPA, Washington, D.C.

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NRC, 2001. *Classifying Drinking Water Contaminants for Regulatory Consideration.* National Research Council Committee on Drinking Water Contaminants, National Academy Press, Washington, D.C.

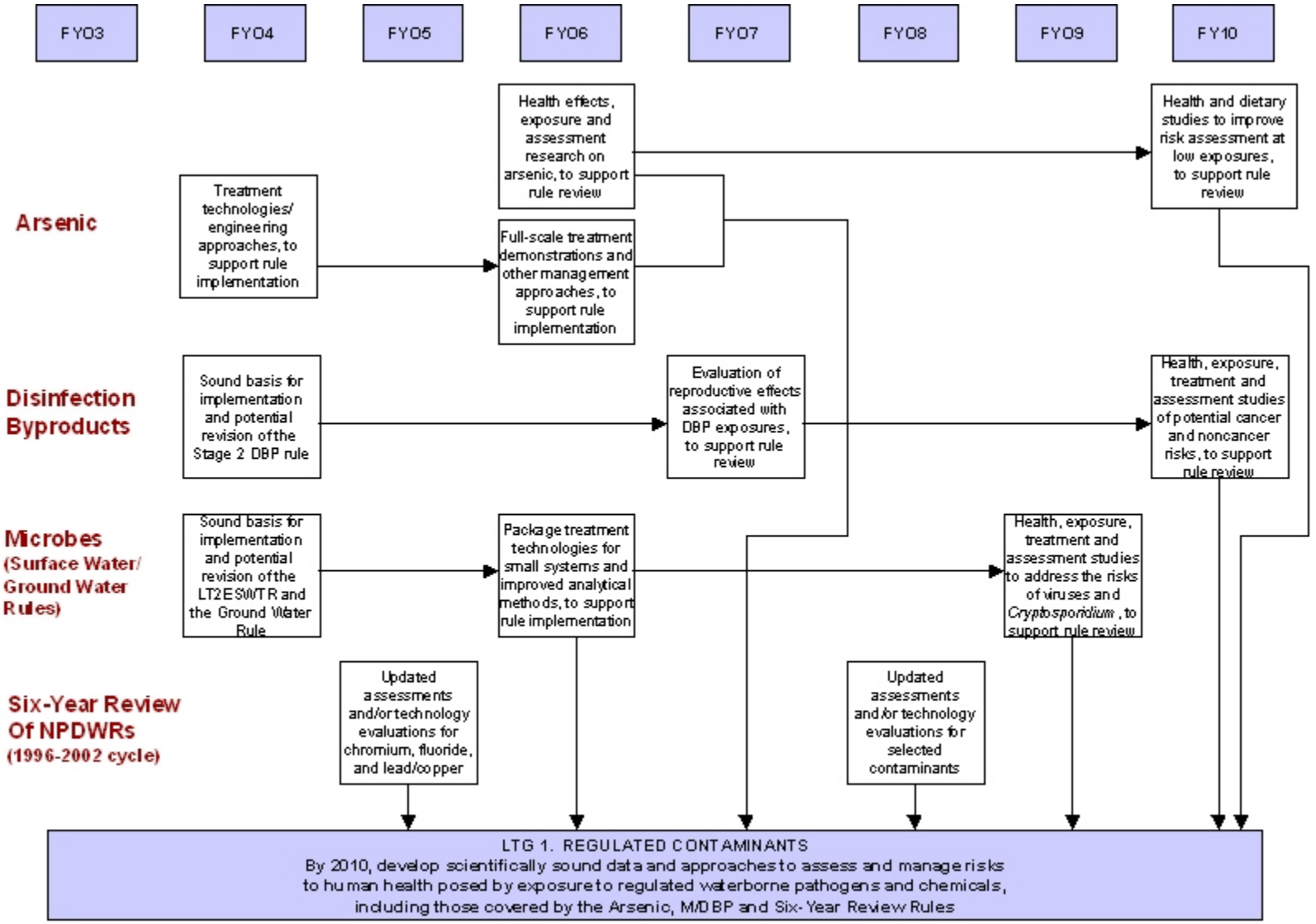

Figure 1. Flow diagram for LTG 1 and associated APGs

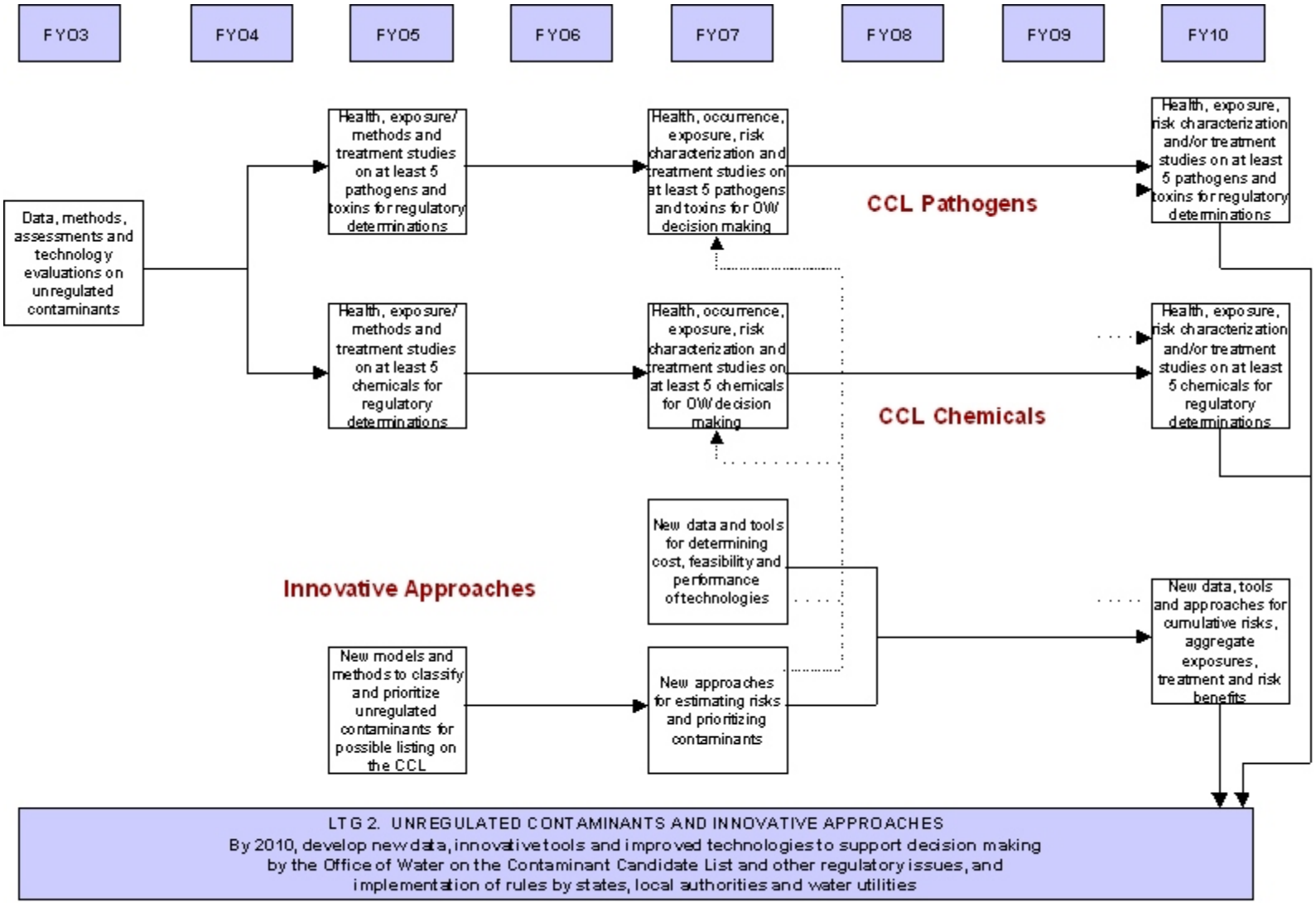

Figure 2. Flow diagram for LTG 2 and associated APGs

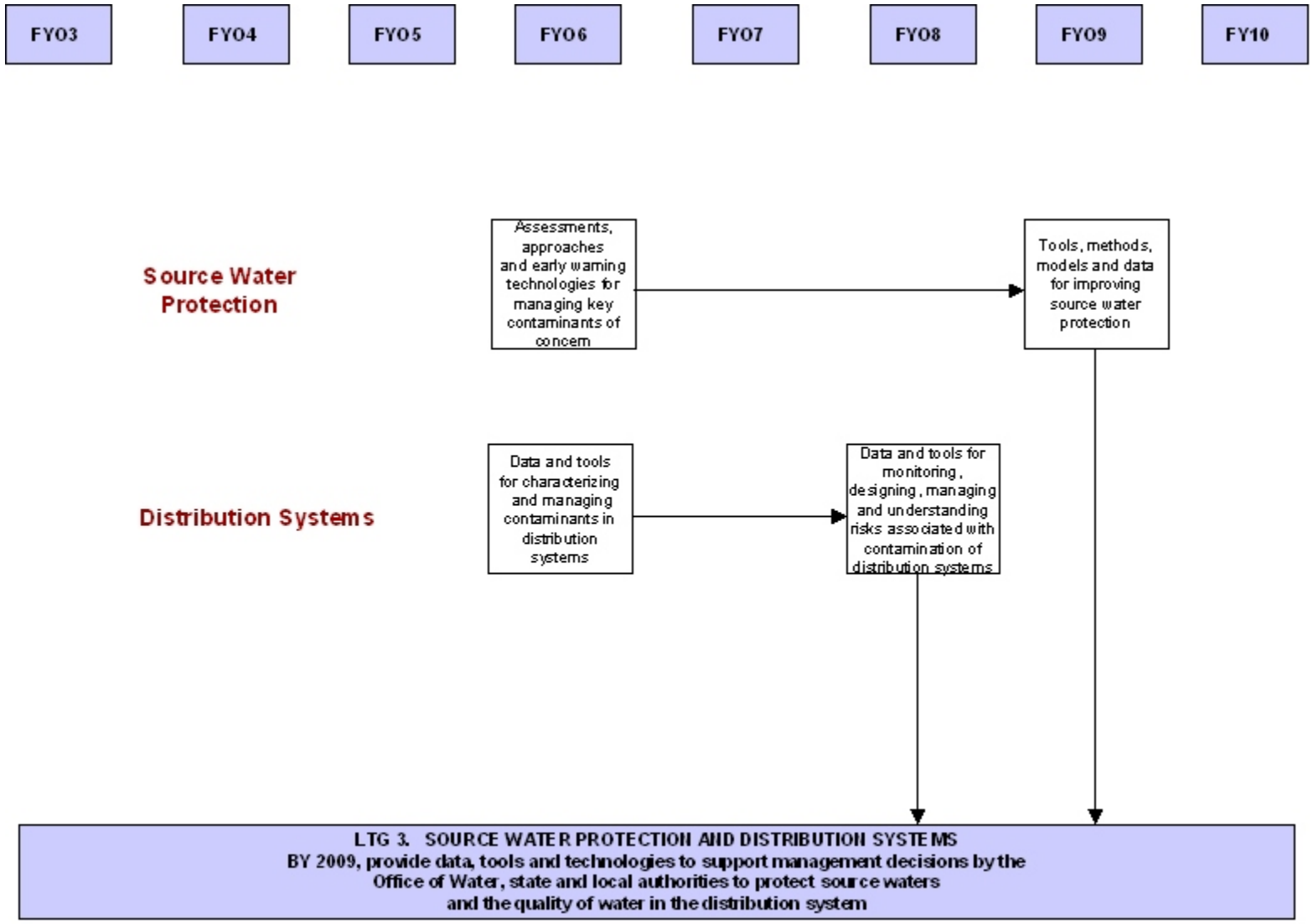

Figure 3. Flow diagram for LTG 3 and associated APGs

TABLE 1. LONG-TERM GOAL 1 - ANNUAL PERFORMANCE GOALS AND MEASURES

LTG 1. REGULATED CONTAMINANTS

By FY 2010, develop scientifically sound data and approaches to assess and manage risks to human health posed by exposure to regulated waterborne pathogens and chemicals, including those addressed by the Arsenic, M/DBP and Six-Year Review Rules

ARSENIC

APG 137[1] - Provide interim reports on the performance of arsenic treatment technologies and/or engineering approaches to the Office of Water and water supply utilities to aid in the implementation of the arsenic rule and the protection of human health [External APG]		**2004**	**ORD[2]**
APM[3]	Design manual for arsenic removal via iron removal processes, summary reports on solid oxidizing media and evaluation of adsorptive media processes [EIMS #25637]	2003	**NRMRL**
APM	Technical manual and computer program to determine cost estimates for use of adsorption media and ion exchange [EIMS #18481]	2003	**NRMRL**
APM	Report on arsenic iron removal/adsorption optimization [EIMS #18477]	2003	**NRMRL**
APM 173	Final reports of full-scale demonstrations of arsenic treatment technologies [External APM] [EIMS #51996]	2004	**NRMRL**
APM	*Environmental Technology Verification (ETV) of two arsenic adsorptive media technologies (from Pollution Prevention and New Technologies MYP) [EIMS # 18282]*	*2004*	***NRMRL***
APM	*Two Environmental Technology Verification (ETV) reports for arsenic treatment technologies (from Pollution Prevention and New Technologies MYP) [EIMS #18282]*	*2004*	***NRMRL***

[1] Numbers are assigned to selected APGs and APMs for internal and GPRA (Government Performance and Results Act) tracking purposes. APG 137 and APM 173 are designated as "external" for the purpose of reporting requirements under GPRA

[2] ORD Laboratories and Centers:
NERL - National Exposure Research Laboratory
NHEERL - National Health and Environmental Effects Research Laboratory
NCEA - National Center for Environmental Assessment
NRMRL - National Risk Management Research Laboratory
NCER - National Center for Environmental Research

[3] Many near-term APMs have hotlinks to project descriptions that reside within EPA's Environmental Information Management System (EIMS). Project descriptions may be accessed using the electronic version of this MYP by clicking the [EIMS #xxxxx] that is associated with the APM.

APG 242 - Provide the Office of Water, states, local authorities and utilities with the results of full-scale treatment demonstration projects and evaluations of other approaches for managing arsenic in drinking water, to support implementation of the current Arsenic Rule		**2006**	**ORD**
APM	Data to assess the stability of arsenic in water distribution systems *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #56082]	2003	**NERL**
APM 435	Data on the treatment conditions which may enhance the solubilization of arsenic containing iron oxides within the distribution system *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #56082]	2005	**NERL**
APM 436	Report on siting of wells and operation to control arsenic	2005	**NRMRL**
APM 437	Final reports of full-scale demonstrations of arsenic treatment technologies [EIMS #51996]	2005	**NRMRL**
APM 438	Updated technology selection/design manuals (including results of demonstration projects) [EIMS #25637]	2005	**NRMRL**
APM 439	Provide report on use of geochemical data to manage risks to public water supply wells from arsenic contamination [EIMS #29571]	2005	**NRMRL**
APM 433	Data on solubilization and mobility of arsenicals from iron oxide residuals produced by drinking water treatment [EIMS #56082]	2006	**NERL**
APM 334	Report on the association of arsenic with iron particles, corrosion byproducts and sediment in drinking water distribution systems *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #29098]	2006	**NRMRL**

APG 243 - Provide a summary of EPA health effects, exposure and assessment research on arsenic, and of research needs to improve the arsenic risk assessment, in support of the Office of Water's Six–Year Review of the Arsenic Rule		**2006**	**ORD**
APM	Data on arsenic species in target foods/groups or composite diets [EIMS #18326]	2003	**NERL**
APM	Identify biomarkers of effect from a population exposed to arsenic in China [EIMS #18599]	2003	**NHEERL**
APM	Report on reproductive effects of arsenic in a Chinese population [EIMS #18599]	2003	**NHEERL**
APM	Report on neurosensory effects of arsenic in a Chinese population [EIMS #18599]	2003	**NHEERL**
APM 205	Preliminary database on arsenic species in target foods/groups to improve arsenic risk characterization [EIMS #18329]	2004	**NERL**

APM 68	Evaluation of urinary arsenic profiles in a second U.S. population (Fallon, NV) to establish human metabolic profiles and urinary biomarkers of exposure	2004	**NHEERL**
APM	Report on cardiovascular effects of arsenic in a Chinese population [EIMS #18599]	2004	**NHEERL**
APM 69	Development of animal models for mechanistic studies of arsenic carcinogenesis	2004	**NHEERL**
APM 260	Peer-reviewed journal article on noncancer risks of arsenic [EIMS #18513]	2004	**NCEA**
APM 235	Genetic and environmental determinants of interindividual variation in arsenic metabolism: Mode of action of arsenic as a carcinogen and toxicant, its relation to risk of chronic exposure, and identification of susceptible subpopulations [EIMS #59304]	2005	**NHEERL**
APM 442	Application of biomarkers in a Chinese population to assess cancer and noncancer effects of arsenic [EIMS #18599]	2005	**NHEERL**
APM 443	Transplacental exposure of rodents to inorganic and methylated arsenicals to assess the carcinogenic response to arsenic in mice	2005	**NHEERL**
APM 432	Characterization of bioavailability of arsenic species from target foods/groups [EIMS #18325]	2006	**NERL**
APM 335	SYNTHESIS DOCUMENT on the health effects of arsenic and research needs to improve human health risk assessment in U.S. populations	2006	**NHEERL** with NCEA and NERL
APM 336	Assessment of exposure to arsenic in humans *in utero* and in early postnatal life	2006	**NHEERL**
APM 337	Mortality studies of arsenic exposure in a Chinese population [EIMS #18599]	2006	**NHEERL**
APM 338	Development and refinement of a physiologically based pharmacokinetic model for arsenic in humans: Use in tissue dosimetry and risk assessment [EIMS #18602]	2006	**NHEERL**

APG 77 - Provide the results of health effects and dietary exposure studies to improve the quantitative assessment of health risks at low levels of exposure to arsenic, in support of the Office of Water's Six-Year Review of the Arsenic Rule		**2010**	**ORD**
APM 215	Evaluation of regional target food composites to estimate arsenic exposure on a regional/national population basis	2007	**NERL**
APM 216	Case-control studies of arsenic health effects in a Chinese population	2007	**NHEERL**
APM 217	Assessment of the contribution of the metabolism of arsenicals by the gastrointestinal flora to overall arsenic exposure	2007	**NHEERL**
APM 218	Age-dependent kinetics in metabolism of inorganic arsenic to evaluate the risk of chronic health effects due to pre-adult exposure	2007	**NHEERL**
APM 219	Modification of arsenic toxicity and carcinogenicity by selenium-arsenic interactions	2007	**NHEERL**
APM 220	Genotype-phenotype correlations and susceptibility to the toxic and carcinogenic effects of arsenic	2007	**NHEERL**

DISINFECTION BYPRODUCTS

APG 12 – ORD will deliver new data and approaches for assessing and managing the potential public health risks associated with exposure to disinfection byproducts (DBPs) to assist the Office of Water in determining the need for revising the Stage 2 DBP rule.		**2004**	**ORD**
APM	Occurrence data for newly identified disinfection byproducts [EIMS #18291]	2003	**NERL**
APM	Improved method for total organic carbon in drinking water [EIMS #18287]	2003	**NERL**
APM	Hazard identification, biomarker and mode of action information to improve risk assessments for selected disinfection byproducts, potassium bromate, dibromoacetonitrile and haloacids [EIMS #18300, 54943]	2003	**NHEERL**
APM	Evaluation of disinfection byproducts and semen quality in men: pilot study *(Also applies to LTG 1, 2007 APG on DBP reproductive effects)* [EIMS #58091]	2003	**NHEERL**
APM	Improve predictive models for identification of carcinogens *(Also applies to LTG 2, 2005 APG on innovative methods)* [EIMS #18468]	2003	**NHEERL**
APM	Report on proteomic and steroidogenic markers that may define mode of action following disinfection byproduct-induced alterations in reproduction and fetal development *(Also applies to LTG 1, 2007 APG on DBP reproductive effects)*	2003	**NHEERL**
APM	Report on an animal model to identify low-dose effects of dibromoacetic acid on reproductive development *(Also applies to LTG 1, 2007 APG on DBP reproductive effects)*	2003	**NHEERL**
APM	Report on disinfection byproducts and adverse reproductive outcomes in California *(Also applies to LTG 1, 2007 APG on DBP reproductive effects)* [EIMS #18295]	2003	**NHEERL**
APM	Report on behavioral and neuropathological studies of dibromoacetic acid [EIMS #18303]	2003	**NHEERL**
APM	Report on the potential colon carcinogenicity of individual and a mixture of trihalomethanes and other disinfection byproducts	2003	**NHEERL**
APM	Report on studies to evaluate if defined mixtures of trihalomethanes are dose-additive [EIMS #18318]	2003	**NHEERL**
APM	Estimate of internal dose for selected disinfection byproducts (chloroform, bromoform, bromodichloromethane, chlorobromomethane) [EIMS #52097]	2003	**NCEA**
APM	Evaluation of organic contaminant (haloacetic acids) using quantitative structure-activity relationships (Topkat) [EIMS #18490]	2003	**NCEA**

APM	Develop a simple procedure for analysis of bromate at occurrence levels in the range of 0.05-2 µg/l, where the cancer risk level is estimated to be 10^{-6} (H. Weinberg) [EIMS #18652]	2003	**NCER**
APM	Provide a kinetic-based model to predict bromate formation during ozonation of natural waters in the presence of natural organic matter (P. Westerhoff) [EIMS #18658]	2003	**NCER**
APM	Characterize previously unidentified disinfection byproducts from different disinfection processes by using new tandem mass spectrometry techniques (R. Minear) [EIMS #18636]	2003	**NCER**
APM	Report on the mechanisms and kinetics of chloramine loss and disinfection byproduct formation in distribution systems. This work includes modeling the formation of NDMA (n-nitrosodimethylamine) *(Also applies to LTG 3, 2006 APG on distribution systems)* (R. Valentine) [EIMS #52287]	2003	**NCER**
APM 61	Human pharmacokinetics of bromodichloromethane: development of data and models for use in rodent-to-human, high-to-low dose, and route-to-route extrapolations to improve risk assessment *(Also applies to LTG 1, 2007 APG on DBP reproductive effects)* [EIMS #20069]	2004	**NHEERL**
APM 62	Multigenerational effects of exposure to bromochloroacetic acid in the drinking water *(Also applies to LTG 1, 2007 APG on DBP reproductive effects)*	2004	**NHEERL**
APM	Examination of the role of glutathione transferase-mediated metabolism in the carcinogenicity of brominated trihalomethanes: an issue of human susceptibility [EIMS #20069]	2004	**NHEERL**
APM 63	Integrated disinfection byproduct mixtures research: Summary of methods development and preliminary toxicological data (Four Lab Study) [EIMS #18314]	2004	**NHEERL** with NERL, NCEA and NRMRL
APM 118	Report on proposed chemical mixtures risk assessment methods and data analysis techniques for application to Four Lab Study results [EIMS #18495]	2004	**NCEA** with NERL, NHEERL and NRMRL
APM	Report on the analysis of Information Collection Rule water quality to predict disinfection byproduct formation and associated changes [EIMS #25645]	2004	**NRMRL**
APM 323	Report on how the distribution of specific ultraviolet absorbance (SUVA) in source waters influences the formation and speciation of brominated disinfection byproducts. Will help optimize treatment goals and devise strategies to comply with the D/DBP rule (J. Kilduff) [EIMS #52901]	2004	**NCER**
APM	Report on the formation and stability of disinfection byproducts from the combined use of ozone as a pre-oxidative treatment with terminal disinfectants chlorine and chloramine (H. Weinberg) [EIMS #18654]	2004	**NCER**

APM	Report of a model for formation of halosubstituted nitriles and cyanogen halides in the Colorado River. Includes determining amino acid precursors and characterizing kinetics and formation mechanisms (T. Olson) [EIMS #18639]	2004	**NCER**
APM 239	Report characterizing the absorption, disposition and oral bioavailability of chlorinated and brominated haloacetates in humans after drinking water containing a naturally occurring mixture of these compounds (I. Schultz) [EIMS #18644]	2004	**NCER**

APG 179 - Support the Office of Water's evaluation of the potential adverse reproductive effects associated with exposure to disinfection byproducts (DBPs) by providing the results of epidemiology studies of male and female reproductive risks, and of research on the mode of action of priority DBPs		**2007**	**ORD**
APM	Evaluation of disinfection byproducts and semen quality in men: pilot study *(Also applies to LTG 1, 2004 APG on DBPs)* [EIMS # 58091]	2003	**NHEERL**
APM	Report on proteomic and steroidogenic markers that may define mode of action following disinfection byproduct-induced alterations in reproduction and fetal development *(Also applies to LTG 1, 2004 APG on DBPs)*	2003	**NHEERL**
APM	Report on an animal model to identify low-dose effects of dibromoacetic acid on reproductive development *(Also applies to LTG 1, 2004 APG on DBPs)*	2003	**NHEERL**
APM	Report on disinfection byproducts and adverse reproductive outcomes in California *(Also applies to LTG 1, 2004 APG on DBPs)* [EIMS #18295]	2003	**NHEERL**
APM 61	Human pharmacokinetics of bromodichloromethane: development of data and models for use in rodent-to-human, high-to-low dose, and route-to-route extrapolations to improve risk assessment *(Also applies to LTG 1, 2004 APG on DBPs)* [EIMS #20069]	2004	**NHEERL**
APM 62	Multigenerational effects of exposure to bromochloroacetic acid in the drinking water *(Also applies to LTG 1, 2004 APG on DBPs)*	2004	**NHEERL**
APM 449	Results of study of disinfection byproduct exposures in men and resultant semen quality [EIMS #58091]	2005	**NHEERL**
APM 441	Results of a second major national study of disinfection byproduct exposures and spontaneous abortions [EIMS #18299]	2006	**NHEERL**
APM 442	Results of study of disinfection byproduct exposures and birth defects in U.S. populations [EIMS #18297]	2006	**NHEERL**
APM 339	Information on the mechanisms of action of priority disinfection byproducts that produce adverse reproductive effects	2006	**NHEERL**

APM 221	Report(s) identifying latent reproductive, developmental and cancer consequences of gestational exposure to disinfection byproducts *(Also applies to LTG 1, 2010 APG on DBPs)*	2007	**NHEERL**
APM 222	Integrated disinfection byproduct mixtures research - Synthesis of toxicological data (cancer, reproductive/developmental, other noncancer effects) from the Four-Lab Study *(Also applies to LTG 1, 2010 APG on DBPs)* [EIMS #18314]	2007	**NHEERL** with NERL, NCEA and NRMRL
APM 223	SYNTHESIS DOCUMENT on reproductive outcomes and exposure to disinfection byproducts [EIMS# 56974]	2007	**NCEA** with NERL and NHEERL

APG 65 - Provide key health, exposure, treatment, and assessment studies to characterize the potential cancer and noncancer risks associated with disinfection byproducts, in support of the Office of Waters review of the Stage 2 Disinfection Byproduct Rule		**2010**	**ORD**
APM 447	Publication on behavioral and neuropathological studies of dibromo-acetonitrile and bromodichloromethane	2005	**NHEERL**
APM 448	Report on the development of models to combine doses of simple, defined mixtures across pathways of exposure for risk characterization of drinking water contaminant mixtures, to support the review of the Stage 2 Disinfection Byproduct Rule *(Also applies to LTG 2, 2010 APG on innovative approaches)* [EIMS #54470]	2005	**NCEA**
APM 340	Information on the carcinogenic mechanisms of action of haloacetonitriles, halonitromethanes and structurally related disinfection byproducts [EIMS #54943]	2006	**NHEERL**
APM 341	Improved epidemiological methods to identify adverse human health outcomes associated with exposure to disinfection byproducts [EIMS #18295]	2006	**NHEERL**
APM 224	Data on the occurrence of byproducts from alternative disinfection processes	2007	**NERL**
APM 225	Report(s) identifying latent reproductive, developmental and cancer consequences of gestational exposure to disinfection byproducts *(Also applies to LTG 1, 2007 APG on DBPs)*	2007	**NHEERL**
APM 226	Develop rapid micro- and macro- methods for screening large numbers of disinfection byproducts. *(Also applies to LTG 2, 2007 APM on innovative approaches)*	2007	**NHEERL**
APM 227	Integrated disinfection byproduct mixtures research - Synthesis of toxicological data (cancer, reproductive/developmental, other noncancer effects) from the Four-Lab Study *(Also applies to LTG 1, 2007 APG on DBPs)* [EIMS #18314]	2007	**NHEERL** with NERL, NCEA and NRMRL

APM 228	Metabolism and dosimetry studies of halonitromethanes and iodonated disinfection byproducts	2007	**NHEERL**
APM 229	Report on the characterization and prediction of disinfection byproducts in distribution systems *(Also applies to LTG 3, 2008 APM on distribution systems)* [EIMS #51973]	2007	**NRMRL**
APM 187	Report(s) on the toxicity and potential carcinogenicity of disinfection byproducts from waters with different levels of bromide and iodide	2008	**NHEERL**
APM 188	Integrated disinfection byproduct mixtures research - Synthesis of quantitative and qualitative chemical analysis of disinfection byproducts from the Four-Lab Study [EIMS #18314]	2008	**NHEERL** with NERL, NCEA and NRMRL
APM 189	Pharmacokinetics and pharmacodynamics of halonitromethanes and iodinated disinfection byproducts to address extrapolation and mode of action issues for risk assessments	2008	**NHEERL**
APM 190	Report(s) on disinfection byproducts that potentially enhance the development of epidemiologically relevant cancer outcomes (colon and urinary bladders)	2008	**NHEERL**
APM 191	Epidemiologic studies on reproductive effects associated with haloacetic acids	2008	**NHEERL**
APM 192	Epidemiology studies on alternative disinfectant processes and their byproducts	2008	**NHEERL**
APM 40	Provide data and reports on the toxicity and potential carcinogenicity of disinfection byproducts (e.g., nitrohalomethanes) generated from disinfection processes other than chlorine	2010	**NHEERL**

SURFACE WATER/GROUND WATER RULES

APG 13 – ORD will provide new scientific data, analytical methods and treatment technologies for waterborne pathogens to support the cost-effective implementation of the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) by local communities, and to support the potential future revision of the rule by the Office of Water		**2004**	**ORD**
APM	Report on waterborne disease in the young and elderly in Washington State community intervention study *(Also applies to LTG 2, 2010 APG on innovative approaches)* [EIMS #18593]	2003	**NHEERL**
APM	Microbial dynamic transmission modeling - Final Report *(Also applies to LTG 2, 2007 APG on innovative approaches)* [EIMS #18473]	2003	**NCEA**
APM	An evaluation of the presence and distribution of genotypes of *Cryptosporidium* in feedlot cattle in Western U.S. to determine the potential human health risk from feedlot run-off (E. Atwill) [EIMS #52903]	2003	**NCER**
APM 204	Improved methods to measure levels of *Cryptosporidium spp.* and *Giardia spp.* in U.S. waters [EIMS #56085]	2004	**NERL**
APM 206	Improved method(s) for CCL-related microbes for use in the Unregulated Contaminant Monitoring Rule (UCMR) [e.g., enteroviruses, caliciviruses, rotaviruses] *(Also applies to LTG 2, 2005 APG on CCL pathogens)* [EIMS #18289, 56094]	2004	**NERL**
APM	Infectious dose of protozoan pathogens and their occurrence in water matrices [EIMS #56085]	2004	**NERL**
APM 64	Waterborne disease: Results of community intervention study #3 *(Also applies to LTG 3, 2010 APG on innovative approaches)* [EIMS #18593]	2004	**NHEERL**
APM 125	Report on the development of improved dose-response models for pathogens: *Cryptosporidium parvum* case study [EIMS #54468]	2004	**NCEA**
APM 240	Report evaluating the infectivity and virulence of the *Cryptosporidium* oocyst that is transferred human-to-human and is responsible for many outbreaks of gastroenteritis (C. Chappell) [EIMS #18630]	2004	**NCER**
APM 287	Development of methods to concentrate, separate and determine viability and infectivity of *Cryptosporidium* and *Giardia*. Proposed method would allow continuous monitoring (S. Tzipori) [EIMS #18647]	2004	**NCER**

APG 244 - Provide the Office of Water with a synthesis report on package treatment technologies for small systems and on improved analytical methods for the detection of waterborne pathogens, to support implementation of the Ground Water and Surface Water Rules		**2006**	**ORD**
APM 449	Evaluate various combinations of microfiltration and ultrafiltration systems, in series and in parallel, to develop filtration credits for protozoan removal following conventional package plant systems **(Small systems)** [EIMS #18551, 18561]	2005	**NRMRL**
APM 450	Summary report of Environmental Technology Verifications for package drinking water treatment technologies for small systems **(Small Systems)** [EIMS #18282]	2005	**NRMRL**
APM 451	SYNTHESIS DOCUMENT on small drinking water systems: State of the industry and treatment technologies to meet Safe Drinking Water Act requirements	2005	**NRMRL**
APM 342	Improved methods for drinking and recreational water microbes; Detection of bacteriophage in water matrices [EIMS #56080]	2006	**NERL**
APM 343	Improved methods for drinking water microbes (Report on advances in protozoan detection procedures) [EIMS #56083]	2006	**NERL**

APG 144 - Provide key health, exposure, treatment and assessment studies to address the risks of viruses and *Cryptosporidium*, in support of the Office of Water's Six-Year Review of the Ground Water and Surface Water Rules		**2009**	**ORD**
APM 452	Report on the use of FoodNet for estimating waterborne disease	2005	**NHEERL**
APM 527	Report on waterborne disease outbreaks in the U.S. in 2001-2002	2005	**NHEERL**
APM 453	Summary report on surrogates for the control of *Cryptosporidium*	2005	**NRMRL**
APM 454	At least three publications evaluating the infectivity, illness and immune response to three non-parvum species of *Cyptosporidium* in healthy human volunteers. This will enable development of improved risk assessment models (C. Chappell) [EIMS #53203]	2005	**NCER**
APM 344	Final report on the application of transmission models for use in pathogen risk assessment to support risk management decisions (case studies include *Cryptosporidium*, coxsackievirus and calicivirus) [EIMS #18473, 22389, 54468, 54476]	2006	**NCEA**
APM 345	Characterization of human exposure to viruses from groundwater	2006	**NERL**

APM 346	Report on waterborne disease outbreaks in the U.S. in 2003-2004	2006	**NHEERL**
APM 347	Report on processes that control transport and fate of chlorine-resistant pathogens in ground waters. Will improve risk assessment of pathogen occurrence and assist in evaluating efficacy of filtration for pathogen removal (M. Brusseau) [EIMS #53144]	2006	**NCER**
APM 348	Publications evaluating the merits of bank filtration for removing pathogens, the use of surrogates to measure pathogen removal and provide quantification of removal mechanisms (E. Bouwer) [EIMS #53129]	2006	**NCER**
APM 349	Two-dimensional model of microbe transport in geochemically and physically heterogeneous porous media, which will be used to generate estimates of pathogen removal by riverbank filtration (J. Ryan) [EIMS #53143]	2006	**NCER**
APM 230	Results from a prospective serological investigation of three communities to evaluate the effectiveness of bank filtration in removing *Cryptosporidium* oocysts (F. Frost) [EIMS #57487]	2007	**NCER**
APM 231	Publication of field tests evaluating effectiveness of riverbank filtration to remove pathogens and particulates in an arid environment. Will evaluate effects of seasonal variation in pumping rate and water level (R. Langford) [EIMS #53141]	2007	**NCER**
APM 193	Report on waterborne disease outbreaks in the U.S. in 2005-2006	2008	**NHEERL**
APM 194	Compare variability of excystation assay/modified excystation assay, neonatal mouse assay and the cell culture assay for chemical disinfectants (ozone, chlorine, chlorine dioxide) and UV inactivation	2008	**NRMRL**
APM 195	Compare/validate the use of the cell culture infectivity assay vs. the neonatal mouse infectivity assay for *Cryptosporidium*	2008	**NRMRL**
APM 196	Publish results from a prospective epidemiological study of the gastrointestinal health effects associated with conventionally treated ground water *(Also applies to LTG 2, 2010 APG on innovative approaches)* (C. Moe) [EIMS #57485]	2008	**NCER**

SIX-YEAR REVIEW

APG 121 - Provide updated assessments and/or technology evaluations for chromium, fluoride and lead/copper, for use by the Office of Water and others in strengthening the public health protection provided by existing rules		**2005**	**ORD**
APM 338	For the Six-Year Review process, conduct/update treatment studies for selected chemicals (chromium) [EIMS #25638]	2004	**NRMRL**
APM 455	Review of the fluoride Maximum Contaminant Level (MCL), Report on the identification and nature of fluoridation chemical equilibrium species resulting from the hydrolysis of fluoridation chemicals [EIMS #29096]	2005	**NRMRL**
APM 456	Report on corrosion chemistry relationships and treatment approaches *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #18501]	2005	**NRMRL**

APG 317 - Provide updated assessments and/or technology evaluations for selected contaminants, for use by the Office of Water and others in strengthening the public health protection provided by existing rules		**2008**	**ORD**
APM 350	External review draft of a health hazard assessment for antimony to support the Six-Year Review of the existing Maximum Contaminant Level	2006	**NCEA**
APM 232	For the Six-Year Review process, conduct/update treatment studies for selected contaminants	2007	**NRMRL**
APM 233	An evaluation of the susceptibility of sensitive populations (infants) to the acute effects of methemoglobin formation from contaminants in drinking water (nitrate, copper and chlorination byproducts) (J. Vanderslice) [EIMS #57490]	2007	**NCER**
APM 197	Development of risk assessments for 3-5 selected contaminants in support of the Office of Water's Six-Year Review	2008	**NCEA**
APM 158	For the Six-Year Review process, conduct/update treatment studies for selected contaminants	2008	**NRMRL**

TABLE 2. LONG-TERM GOAL 2 - ANNUAL PERFORMANCE GOALS AND MEASURES

LTG 2. UNREGULATED CONTAMINANTS AND INNOVATIVE APPROACHES

By FY 2010, develop new data, innovative tools and improved technologies to support decision making by the Office of Water on the Contaminant Candidate List and other regulatory issues, and implementation of rules by states, local authorities and water utilities

CCL PATHOGENS

APG[1] –The Office of Water will have data, methods, assessments and technology evaluations necessary to support scientifically sound risk assessment and risk management decisions on unregulated contaminants of potential public health concern		**2003**	**ORD[2]**
APM[3] 101	Develop methodology to identify and characterize *H. pylori*, caliciviruses and sources of human pathogens in water [EIMS #15806, 56080]	2003	**NERL**
APM	Occurrence data and/or method performance results for selected CCL pathogens [*Mycobacterium avium, Helicobacter pylori*, caliciviruses] [EIMS #18289]	2003	**NERL**
APM	Data on the reproductive toxicity of microcystin	2003	**NHEERL**
APM 38	Report on the potential health risks associated with three CCL pathogens [coxsackievirus, calicivirus, *Mycobacterium*] [EIMS #22389]	2003	**NCEA**
APM	Report on optimized and validated methods to detect and determine the prevalence of infectious microsporidia in environmental waters (P. Rochelle) [EIMS #18642]	2003	**NCER**
APM	Publication of improved methods for detecting variants of *Mycobacterium avium* complex, determining infectivity, evaluating susceptibility to disinfection, and determining factors influencing distribution in municipal water systems (G. Cangelosi, T. Ford) [EIMS #19589, 18631]	2003	**NCER**
APM	Development of an improved method for quantitative detection of infectious coxsackieviruses and echoviruses (M. Yates) [EIMS #18659]	2003	**NCER**

[1] Numbers are assigned to selected APGs and APMs for internal and GPRA (Government Performance and Results Act) tracking purposes

[2] ORD Laboratories and Centers:
NERL - National Exposure Research Laboratory
NHEERL - National Health and Environmental Effects Research Laboratory
NCEA - National Center for Environmental Assessment
NRMRL - National Risk Management Research Laboratory
NCER - National Center for Environmental Research

[3] Many near-term APMs have hotlinks to project descriptions that reside within EPA's Environmental Information Management System (EIMS). Project descriptions may be accessed using the electronic version of this MYP by clicking the [EIMS #xxxxx] that is associated with the APM.

APG 122 – Provide the Office of Water with the results of health effects, exposure/methods and treatment studies, in support of decisions to regulate or not regulate at least five pathogens and toxins on the Contaminant Candidate List		**2005**	**ORD**
APM 206	Improved method(s) for CCL-related microbes for use in the Unregulated Contaminant Monitoring Rule (UCMR) [e.g., enteroviruses, caliciviruses, rotaviruses] *(Also applies to LTG 1, 2004 APG on Surface Water/Ground Water)* [EIMS #18289, 56094]	2004	**NERL**
APM 175	Report on screening studies to determine inactivation of *H. pylori* by chloramine and UV [EIMS #18574]	2004	**NRMRL**
APM 176	Project report on effectiveness of conventional treatment and filtration for cyanobacteria (blue-green algae) [EIMS #25636]	2004	**NRMRL**
APM	Screening studies to determine the effectiveness of chloramine to inactivate microsporidia spores [EIMS #18573]	2004	**NRMRL**
APM	Report on the detection of opportunistic pathogens (*E. coli*, *Aeromonas*, *Mycobacterium*) in biofilms using molecular detection techniques *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #18570]	2004	**NRMRL**
APM 285	Reports from two studies of microsporidia attempting to develop methods to detect, determine viability and infectivity, and determine the prevalence in environmental waters to improve risk assessment (W. Sonzogni and P. Rochelle) [EIMS #52906, 18642]	2004	**NCER**
APM 286	Report on the development and validation of new techniques for rapid detection of *Helicobacter pylori* from environmental samples (M. Shahamat) [EIMS #18645]	2004	**NCER**
APM 457	Occurrence data for CCL-related cyanobacterial toxins [EIMS #56094]	2005	**NERL**
APM 458	Evaluation of potential detection method for *Helicobacter pylori* occurrence studies [EIMS #15806]	2005	**NERL**
APM 459	Report on the link between the distribution system and *Mycobacterium avium* complex (MAC) found in clinical cases *(Also applies to LTG 3, 2006 APG on distribution systems)*	2005	**NHEERL**
APM 460	Development of a serological method for microsporidia [EIMS #54617]	2005	**NHEERL**
APM 461	Cyanotoxins: Data on anatoxin-a mechanism of cholinergic neurotoxicity using neurobehavioral tests	2005	**NHEERL**
APM 462	Report on disinfection efficacy of adenovirus and bacteriophage in drinking water [EIMS #18576]	2005	**NRMRL**
APM 463	Report on survival of calicivirus in surface and subsurface water and its impact on drinking water treatment [EIMS #20653]	2005	**NRMRL**

APM 464	Report on oxidation of cyanobacteria (algal) toxins in drinking water treatment [EIMS #20655]	2005	**NRMRL**
APM 465	Report on characterization of drinking water distribution system biofilm microbial populations using molecular detection methods *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #20654, 51701]	2005	**NRMRL**
APM 466	Report on the development of DNA microarrays to detect multiple pathogens (including *H. pylori*) in a single water sample and using mRNA analysis to determine viability. *(Also applies to LTG 2, 2005 APG on innovative approaches)* (D. Chandler) [EIMS #18629]	2005	**NCER**
APM 467	Publications evaluating the effectiveness of UV disinfection at inactivating drinking water pathogens and the influence of water quality parameters on effectiveness, to assist in the use and design of UV disinfection systems (K. Linden) [EIMS #53204]	2005	**NCER**

APG 180 – Provide health effects, occurrence, exposure, risk characterization and treatment studies on at least five unregulated pathogens and toxins, to support Office of Water decision making on the Contaminant Candidate List		**2007**	**ORD**
APM 124	Provide risk characterization and related support materials that provide scientific rationale for CCL decision making [EIMS #54469]	2004	**NCEA**
APM 339	Report on the role of municipal sewage effluents in contributing to the occurrence of enterohemorrhagic *Escherichia coli* (EHEC) in watersheds *(Also applies to LTG 3, 2006 APG on source water protection)* [EIMS #20645]	2004	**NRMRL**
APM 468	Report on approaches for assessing the disease burden associated with waterborne disease outbreaks [EIMS #18496]	2005	**NCEA**
APM 351	Improved method(s) for CCL related microbes *(Mycobacterium paratuberculosis*, rotavirus, hepatitis E virus, pathogenic fungal species)	2006	**NERL**
APM 352	Characterization of the virulence of potential CCL pathogens (bacteria in biofilms and/or cooling towers; Includes methods to distinguish virulent and avirulent isolates)	2006	**NERL**
APM 353	Characterization of human exposure to mycobacteria	2006	**NERL**
APM 354	Evaluation of potential biomarkers of exposure and effects for selected cyanobacterial toxins in rodent studies	2006	**NHEERL**
APM 355	Metabolism and dosimetry studies of cyanobacteria toxins to evaluate intoxication and detoxication pathways and determine appropriate dose metrics	2006	**NHEERL**

APM 356	Assessments of CCL pathogens for use in making regulatory determinations and CCL listing decisions (cyanobacteria and others to be determined) [EIMS #58162]	2006	**NCEA**
APM 357	Final report on pathogen dose-response for use in characterizing risks associated with pathogens in drinking water and the development of effective treatment options [EIMS #54468]	2006	**NCEA**
APM 358	Conduct pilot/full scale evaluations (cost and performance) of the most promising treatment processes to control selected CCL pathogens	2006	**NRMRL**
APM 359	Conduct cost and performance evaluations for advanced oxidation processes (e.g., ozone/UV/hydrogen peroxide combinations) to control selected CCL microbial contaminants in small drinking water systems **(Small Systems)**	2006	**NRMRL**
APM 360	Evaluate control of *Aeromonas* in distribution systems using chlorine and chloramine *(Also applies to LTG 3, 2006 APG on distribution systems)* [EIMS #18575]	2006	**NRMRL**
APM 234	Determine the validity of, and methods for, extrapolating animal data to humans for the assessment of the health effects of cyanobacterial toxins	2007	**NHEERL**
APM 235	Develop standardized, validated assays and rapid analytical methods to detect selected cyanobacterial toxins in water	2007	**NHEERL**
APM 236	Population-based studies on the health effects associated with microcystins	2007	**NHEERL**
APM 237	Comparison of *Mycobacterium* disease isolates and distribution system isolates *(Also applies to LTG 3, 2008 APG on distribution systems)*	2007	**NHEERL**
APM 238	Characterization of human exposure to *Legionella*	2007	**NERL**
APM 239	Report on biofilm and regrowth issues associated with non-tuberculous mycobacteria *(Also applies to LTG 3, 2008 APG on distribution systems)*	2007	**NRMRL**
APM 240	Conduct pilot/full scale evaluations (cost and performance) of the most promising treatment processes to control selected CCL pathogens	2007	**NRMRL**
APM 241	Evaluate ultraviolet irradiation for inactivation of *Mycobacterium spp*. and cyanobacteria	2007	**NRMRL**
APM 242	Evaluate inactivation of human calicivirus by chemical disinfectants (chlorine, chloramine, chlorine dioxide, ozone)	2007	**NRMRL**
APM 243	Evaluate inactivation of human calicivirus by ultraviolet irradiation	2007	**NRMRL**

APG 66 – Provide health effects, exposure, risk characterization and/or treatment studies on at least five unregulated pathogens and toxins on the Contaminant Candidate List, to support the Office of Water's regulatory determination process		**2010**	**ORD**
APM 199	Pharmacokinetics and pharmacodynamics of cyanobacterial toxins to address extrapolation and mode of action issues for risk assessment of CCL contaminants	2008	**NHEERL**
APM 45	Treatment screening studies for newly identified CCL microbial pathogens	2009	**NRMRL**
APM 46	Screening studies to evaluate sensitivity of coxsackievirus and echovirus to disinfection treatment (chlorine, chlorine dioxide, ozone and UV)	2009	**NRMRL**
APM 41	Evaluate ultraviolet irradiation for inactivation of *Mycobacterium spp*. and cyanobacteria	2010	**NRMRL**
APM 42	Evaluate inactivation of human calicivirus by chemical disinfectants (chlorine, chloramine, chlorine dioxide, ozone)	2010	**NRMRL**

CCL CHEMICALS

APG –The Office of Water will have data, methods, assessments and technology evaluations necessary to support scientifically sound risk assessment and risk management decisions on unregulated contaminants of potential public health concern		**2003**	**ORD**
APM 66	Pharmacokinetics of dichloropropanes and dichloropropenes [EIMS #18588]	2003	**NHEERL**
APM	Evaluate *in vitro* technologies to study metabolism of dichloropropanes [EIMS #18588]	2003	**NHEERL**
APM	Report on the *in vitro* genetic toxicity of 1,3-dichloropropane and 1,1-dichloropropene [EIMS #18587]	2003	**NHEERL**
APM	Data on mode of action and potential carcinogenicity of 1,3-dichloropropane and 1,1-dichloropropene [EIMS #18587]	2003	**NHEERL**
APM 56	Complete a report for external peer review on the available information and approaches to assess developmental effects in children from exposure to chemicals on the drinking water CCL [EIMS #54535]	2003	**NCEA**
APM 72	Report on identifying CCL pesticides for cumulative risk assessment [EIMS #22448]	2003	**NCEA**
APM 171	Publish an interim report on the treatability of selected endocrine disrupting chemicals [estradiol, estriol, ethynylestradiol, progesterone, testosterone, and dihydrotestosterone] [EIMS #18564]	2003	**NRMRL**

APG 123 – Provide the Office of Water with the results of health effects, exposure/methods, risk characterization and treatment studies, in support of decisions to regulate or not regulate at least five unregulated chemicals on the Contaminant Candidate List		**2005**	**ORD**
APM 202	Improved method(s) for CCL-related chemicals for use in the Unregulated Contaminant Monitoring Rule (UCMR) [e.g., alachlor ESA and other acetanilide pesticide degradation products, organotins] [EIMS #18290, 18331, 18406, 56081, 56097]	2004	**NERL**
APM	Immunotoxicity of dibutyltin dichloride, an organotin used to stabilize PVC pipes, on the developing and mature immune system [EIMS #54524]	2004	**NHEERL**
APM	Publications describing the effects and molecular mode of action of organotins on an *in vitro* model of neuronal development to use as a biomarker of developmental neurotoxicity [EIMS #18589]	2004	**NHEERL**
APM	Publications describing the characterization of learning impairments and structural correlates in the limbic system resulting from developmental exposure to methytins in drinking water [EIMS #18589]	2004	**NHEERL**

APM 170	Publish a technical report on treatability of three chemicals on the 1998 CCL to provide information to the program offices for use in the regulatory determination process [MTBE, perchlorate and several organics] [EIMS #18471, 18474, 18475]	2004	**NRMRL**
APM	Initial development of the treatability database for drinking water chemicals [EIMS #25654]	2004	**NRMRL**
APM	Results of membrane treatment of semi-volatile CCL chemicals [EIMS #51960]	2004	**NRMRL**
APM	Handbook of reverse osmosis (RO) treatment for CCL and other chemicals [EIMS #18562]	2004	**NRMRL**
APM	Results of lime softening for soluble CCL chemicals [EIMS #51967]	2004	**NRMRL**
APM	Evaluate conventional and innovative treatment options for controlling perchlorate in drinking water [EIMS #18475]	2004	**NRMRL**
APM	Results of oxidation screening studies for CCL organic chemicals [EIMS #51964]	2004	**NRMRL**
APM	Initial development of the treatability data base for drinking water microbials	2004	**NRMRL**
APM 20	*Polar organic chemical integrative sampling (POCIS) and LC-ES/ITMS for assessing selected prescription and illicit drugs in treated sewage effluents (from Water Quality MYP)*	*2005*	***NERL***
APM 21	*Levels of synthetic musks in municipal wastewater for estimating biota exposure in receiving waters (from Water Quality MYP)*	*2005*	***NERL***
APM 23	*"Virtual" Symposium: State of the Science – Pharmaceuticals/Personal Care Products (P/PCPs) as environmental pollutants (from Water Quality MYP)*	*2005*	***NERL***
APM 24	*Review of environmental forensic techniques (e.g., high resolution MS and ICE software) over the last decade (from Water Quality MYP)*	*2005*	***NERL***
APM 489	Describe the pharmacokinetics of oxygenate mixes in young and elderly populations [EIMS #18591]	2005	**NHEERL**
APM 471	Data on the developmental neurotoxicity of butyltins [EIMS #18589]	2005	**NHEERL**
APM 472	Data on the immunotoxicity of selected CCL contaminants: organotin leachates. Do organotin stabilizers used in PVC pipe affect the developing or mature immune system? [EIMS #18589]	2005	**NHEERL**
APM 473	Provide risk characterization and related support materials that provide scientific rationale for CCL decisions (including bromobenzene, RDX, chlorophenol, and others to be determined) [EIMS #18709, 54469, 54474, 56650]	2005	**NCEA**

APM 474	Develop and test innovative advanced oxidation process technologies for destruction of MTBE in small drinking water systems **(Small Systems)** [EIMS #18554]	2005	**NRMRL**
APM 475	Conduct performance evaluations for utilizing advanced oxidation processes for treating emerging CCL contaminants [EIMS #25639]	2005	**NRMRL**
APM 476	Evaluate small system innovative treatment options for controlling perchlorate in drinking water **(Small Systems)**	2005	**NRMRL**

APG 181 – Provide health effects, exposure, risk characterization and treatment studies on at least five unregulated chemicals, to support Office of Water regulatory decision making on the Contaminant Candidate List		**2007**	**ORD**
APM 477	Final report on the treatability of selected endocrine disrupting chemicals (EDCs) [EIMS #18564]	2005	**NRMRL**
APM 361	Improved method for CCL-related chemicals (e.g., NDMA) [EIMS #18339]	2006	**NERL**
APM 362	Report on the identification of CCL chemicals with common metabolism-pharmacokinetic models	2006	**NHEERL**
APM 363	Report on the identification of CCL chemicals with common modes of action	2006	**NHEERL**
APM 364	Metabolism and dosimetry studies of CCL toxicants to evaluate intoxication and detoxication pathways and to determine appropriate dose metrics	2006	**NHEERL**
APM 365	Comparative risk assessment of life-cycle environmental impacts of alternative fuels, to support UCMR and CCL determinations	2006	**NCEA**
APM 366	Leaching studies to characterize organotin concentrations in distribution systems *(Also applies to LTG 3, 2006 APG on distribution systems)*	2006	**NRMRL**
APM 367	Determine what the bank filtration removal efficiency is for pesticides, endocrine disruptors and other organic contaminants [EIMS #25653]	2006	**NRMRL**
APM 368	Conduct pilot/full scale evaluations (cost and performance) of the most promising treatment processes to control selected CCL chemicals	2006	**NRMRL**
APM 16	*Improved detection methods for, and occurrence levels of, pharmaceuticals and personal care products in effluents, surface waters, treated drinking water and ground water (from Water Quality MYP) (B. Brownawell, D. Graham, H. Weinberg and L. Roberts)* [EIMS #53139, 53140, 53142, 53137]	2006	**NCER**

APM 17	*An evaluation of how effective wastewater treatment practices are at decreasing levels of pharmaceuticals and antiseptics in drinking water (from Water Quality MYP) (B. Brownawell, D. Graham and L. Roberts)* [EIMS #53139, 53140, 53137]	2006	**NCER**
APM 18	*An evaluation of conferred antibiotic resistance in microbial communities resulting from pharmaceuticals and personal care products in the water (from Water Quality MYP) (D. Graham and H. Weinberg)* [EIMS #53140, 53142]	2006	**NCER**
APM 19	*An evaluation of the influence of amphiphiles on the fate and transport of pharmaceuticals in the environment (from Water Quality MYP) (G. Kibbey and D. Sabatini)* [EIMS #53138]	2006	**NCER**
APM 244	Data on the reproductive toxicity of selected CCL contaminants	2007	**NHEERL**
APM 245	Data on the mode of action and carcinogenicity of selected CCL contaminants	2007	**NHEERL**
APM 246	Pharmacokinetics and pharmacodynamics of CCL chemicals to address extrapolation and mode of action issues for risk assessments	2007	**NHEERL**
APM 247	Develop animal models of human genetic polymorphisms to assess potential susceptibility to CCL chemicals *(Also applies to LTG 2, 2007 APG on innovative approaches)*	2007	**NHEERL**
APM 248	Determine treatability of endocrine disrupting chemicals (e.g., surfactant degradation products) [EIMS #18564]	2007	**NRMRL**
APM 249	Conduct pilot/full scale evaluations (cost and performance) of the most promising treatment processes to control selected CCL chemicals	2007	**NRMRL**
APM 250	Assessment and management of organotins in source waters *(Also applies to LTG 3, 2009 APG on source water protection)*	2007	**NRMRL**
APM 251	Small system treatment options for CCL chemicals **(Small Systems)**	2007	**NRMRL**
APM 252	Research results to indicate whether oral aluminum (Al) bioavailability is independent of the Al species consumed in water, to support the risk assessment for Al in drinking water (R. Yokel) [EIMS #57491]	2007	**NCER**
APM 253	An evaluation of whether aluminum in drinking water can induce neuronal injury and whether aging increases susceptibility (J. Savory) [EIMS #57489]	2007	**NCER**

APG 67 – Provide health effects, exposure, risk characterization and/or treatment studies on at least five unregulated chemicals on the Contaminant Candidate List, to support the Office of Water's regulatory determination process		**2010**	**ORD**
APM 200	Improved method(s) for CCL-related chemicals for use in Unregulated Contaminant Monitoring Regulations	2008	**NERL**
APM 201	Immunotoxicity assessment of priority CCL toxicants	2008	**NHEERL**
APM 202	Report on applications of computational toxicology to the development of prototype-based approaches for the CCL	2008	**NHEERL**
APM 47	Pharmacokinetics and pharmacodynamics of CCL toxicants to address extrapolation and mode of action issues for risk assessments	2009	**NHEERL**
APM 48	Determine treatability of pharmaceutically active compounds and degradation products [EIMS #18564]	2009	**NRMRL**
APM 49	Treatment options for selected CCL chemicals	2009	**NRMRL**
APM 43	Screening studies (bench scale) for newly identified CCL #3 chemicals	2010	**NRMRL**

INNOVATIVE APPROACHES

APG 124 - Provide the Office of Water with new predictive models and innovative methods to assist in classifying and prioritizing unregulated chemicals and pathogens for possible listing on the next Contaminant Candidate List		**2005**	**ORD**
APM	Computational chemistry and Structure-Activity Relationship (SAR) modeling of chemical contaminants in drinking water [EIMS #18468]	2003	**NHEERL**
APM	Improve predictive models for identification of carcinogens *(Also applies to LTG 1, 2004 APG on DBPs)* [EIMS #18468]	2003	**NHEERL**
APM 478	Report(s) detailing merged computational and genomic/proteomic approaches to relate mode of action studies in laboratory animals to human outcomes	2005	**NHEERL**
APM 479	Implementation of novel proteomic approaches to identify and characterize biomarkers of effect and elucidate mode of action following exposure to drinking water contaminants	2005	**NHEERL**
APM 535	Quantitative Structure-Activity Relationship (QSAR) models to predict cancer potency for CCL chemicals [EIMS #22490]	2005	**NCEA**
APM 466	Report on the development of DNA microarrays to detect multiple pathogens (including *H. pylori*) in a single water sample and using mRNA analysis to determine viability *(Also applies to LTG 2, 2005 APG on CCL pathogens)* (D. Chandler) [EIMS #18629]	2005	**NCER**

APG 189 – Develop new data and tools for determining the cost, feasibility and performance of technologies, to support management decisions by the Office of Water, states, local authorities and water utilities		**2007**	**ORD**
APM	Develop cost models for selected separation and disinfection technologies [EIMS #18565]	2004	**NRMRL**
APM 482	Maintenance/update of the treatability data base (drinking water chemicals and microbials, with initial focus on CCL contaminants) [EIMS #25654]	2005	**NRMRL**
APM 369	Evaluation of cost and feasibility of small slow sand filtration technology for indirect drinking water reuse	2006	**NRMRL**
APM 370	Evaluation of cost and performance of new filtration and destruction technologies for indirect drinking water reuse	2006	**NRMRL**

APG 182 – Develop new approaches for estimating risks and prioritizing contaminants of potential concern, for use by the Office of Water in developing future Contaminant Candidate Lists and making other management decisions		**2007**	**ORD**
APM	Microbial dynamic transmission modeling - Final Report *(Also applies to LTG 1, 2004 APG on Surface Water/Ground Water)* [EIMS #18473]	2003	**NCEA**
APM 128	Report on the application of physiologically based pharmacokinetic modeling to assess the impacts of changes in health status due to variance in susceptibility associated with exposure to CCL chemicals [EIMS #18480]	2004	**NCEA**
APM 536	Report on statistical models/approaches for assessing cancer risk to children, for refining risk assessments used by the Office of Water in establishing and reviewing Maximum Contaminant Levels [EIMS #51924]	2005	**NCEA**
APM 371	Data on drinking water pathogens using a proteomics based approach [EIMS #18338]	2006	**NERL**
APM 372	Review of selected approaches for application of Quantitative Structure-Activity Relationships (QSAR) for extrapolation of data for CCL development	2006	**NHEERL**
APM 254	Report on an approach of using microarrays in conjunction with human tissue cultures for identifying virulence factors of waterborne pathogens	2007	**NERL**
APM 255	Evaluation of the usefulness of virulence factor activity relationships (VFARs) in characterizing CCL pathogens	2007	**NERL**
APM 256	Development of rapid micro- and macro-methods for screening large numbers of contaminants *(Also applies to LTG 1, 2010 APG on DBPs)*	2007	**NHEERL**
APM 257	Identification of potential biomarkers of exposure and effect for use in activity-based assays applicable to unregulated drinking water contaminants	2007	**NHEERL**
APM 258	Report on potential applications of computational toxicology to the development of prototype-based approaches for CCL development	2007	**NHEERL**
APM 259	Summary document on the utility of computational modeling (QSARs), genetox assays (microcomet), toxicokinetics, and alternative animal models to predict health outcomes	2007	**NHEERL**
APM 260	Develop animal models of human genetic polymorphisms to assess potential susceptibility to CCL chemicals *(Also applies to LTG 2, 2007 APG on CCL chemicals)*	2007	**NHEERL**
APM 261	Web-enabled, secure treatability data base for chemicals and microbes	2007	**NRMRL**

APG 68 - Provide reports with new data, tools, and approaches for determining cumulative risks, aggregate exposures, treatment, and the benefits of risk management decisions for drinking water contaminants		**2010**	**ORD**
APM	Report on waterborne disease in the young and elderly in Washington State community intervention study *(Also applies to LTG 1, 2004 APG on Surface Water/Ground Water)* [EIMS #18593]	2003	**NHEERL**
APM	Report on approaches for assessing the cumulative risk of drinking water mixtures [EIMS #18494]	2003	**NCEA**
APM 64	Waterborne disease: Results of community intervention study #3 *(Also applies to LTG 1, 2004 APG on Surface Water/Ground Water)* [EIMS #18593]	2004	**NHEERL**
APM 484	Report on the use of epidemiologic data as a tool for estimating the health benefits of water filtration	2005	**NHEERL**
APM 448	Report on the development of models to combine doses of simple, defined mixtures across pathways of exposure for risk characterization of drinking water contaminant mixtures, to support the review of the Stage 2 Disinfection Byproduct Rule *(Also applies to LTG 1, 2010 APG on DBPs)* [EIMS #54470]	2005	**NCEA**
APM 373	Conduct health benefit studies evaluating the reduction in exposure to microorganisms in bank filtration versus conventional treatment	2006	**NHEERL**
APM 262	Report on the development of risk assessment methods to characterize health risks from exposure to complex mixtures including consideration of potential risk from unidentified components using data from Four Lab study [EIMS #18495]	2007	**NCEA**
APM 203	Development of technical guidance on microbial dose-response modeling and population dynamic transmission modeling for microbial risk assessment guidelines	2008	**NCEA**
APM 196	Publish results from a prospective epidemiological study of the gastrointestinal health effects associated with conventionally treated ground water *(Also applies to LTG 1, 2009 APG on Surface Water/Ground Water)* (C. Moe) [EIMS #57485]	2008	**NCER**
APM 205	Report on molecular microarrays for detection of non-pathogenic bacteria and bacterial pathogens in drinking water source waters *(Also applies to LTG 3, 2009 APG on source water protection)*	2008	**NRMRL**
APM 50	SYNTHESIS DOCUMENT on the use of mixtures risk assessment approaches to inform drinking water regulatory decisions	2009	**NCEA**
APM 51	Development of at least one new approach to determine the relative risks posed by pathogens in drinking waters, the passage of pathogens through treatment barriers, or the vulnerability of distribution systems to pathogen intrusion or growth *[Placeholder for Jan 03 solicitation (RFA)]*	2009	**NCER**
APM 44	Utilization of treatability data base to improve modeling of drinking water treatment for selected chemical and microbial contaminants	2010	**NRMRL**

TABLE 3. LONG-TERM GOAL 3 - ANNUAL PERFORMANCE GOALS AND MEASURES

LTG 3. SOURCE WATER PROTECTION AND DISTRIBUTION SYSTEMS

By 2009, provide data, tools and technologies to support management decisions by the Office of Water, state and local authorities to protect source waters and the quality of water in the distribution system

SOURCE WATER PROTECTION

APG 248[1] – Develop assessments, approaches and early warning technologies for managing key contaminants of concern, to assist drinking water utilities in protecting source waters		**2006**	**ORD[2]**
APM[3]	Interim report on characterization of *Cryptosporidium* and *Giardia* in combined sewer overflows (CSOs) [EIMS #20670]	2003	**NRMRL**
APM	*Toward a green pharmacy - Cradle to cradle stewardship of drugs for minimizing their environmental disposition while promoting human health (from Water Quality MYP)*	*2004*	***NERL***
APM	Report on early warning upstream monitoring network to protect source waters [EIMS #18560]	2004	**NRMRL**
APM 339	Report on the role of municipal sewage effluents in contributing to the occurrence of enterohemorrhagic *Escherichia coli* (EHEC) in watersheds *(Also applies to LTG 2, 2007 APG on CCL pathogens)* [EIMS #20645]	2004	**NRMRL**
APM 486	Assessment of Best Management Practices (BMP) for atrazine in rural watersheds [EIMS #51704]	2005	**NRMRL**
APM 487	Final report on characterization of *Cryptosporidium* and *Giardia* in combined sewer overflows (CSOs) [EIMS #20670]	2005	**NRMRL**
APM 374	Improved method for rapid detection of water quality changes *(Also applies to LTG 3, 2006 APG on distribution systems)*	2006	**NERL**

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[1] Numbers are assigned to selected APGs and APMs for internal and GPRA (Government Performance and Results Act) tracking purposes

[2] ORD Laboratories and Centers:
NERL - National Exposure Research Laboratory
NHEERL - National Health and Environmental Effects Research Laboratory
NCEA - National Center for Environmental Assessment
NRMRL - National Risk Management Research Laboratory
NCER - National Center for Environmental Research

[3] Many near-term APMs have hotlinks to project descriptions that reside within EPA's Environmental Information Management System (EIMS). Project descriptions may be accessed using the electronic version of this MYP by clicking the [EIMS #xxxxx] that is associated with the APM.

APM 375	Data on the utility of chemical indicators of human fecal contamination and their correlation to health effects	2006	**NERL**
APM 376	Biosensor evaluation and demonstration as a tool to protect source waters [EIMS #18563]	2006	**NRMRL**
APM 377	State-of-the-science report for on-site sewage management and septic systems technology	2006	**NRMRL**
APM 378	Placement of Best Management Practices (BMPs) in urban watersheds to meet water quality goals	2006	**NRMRL**
APM	*Watershed boundary condition identification (from Global Change MYP) [EIMS #51700]*	*2006*	***NRMRL***

APG 145 – Provide the Office of Water, states and other stakeholders with tools, methods, models and data for improving source water protection		**2009**	**ORD**
APM 250	Assessment and management of organotins in source waters *(Also applies to LTG 2, 2007 APG on CCL chemicals)*	2007	**NRMRL**
APM 264	Optimization of Best Management Practice (BMP) design/location for atrazine	2007	**NRMRL**
APM 265	Report on modeling and placement of structural Best Management Practices (BMPs) as a source water protection approach	2007	**NRMRL**
APM 266	Develop neural network model for Kentucky River to indicate presence, concentration, age and source of microbial pathogens. Can be used for qualitative risk assessments of pathogen inputs into identified water source (G. Brion) [EIMS #57486]	2007	**NCER**
APM 205	Report on molecular microarrays for detection of non-pathogenic bacteria and bacterial pathogens in drinking water source waters *(Also applies to LTG 2, 2010 APG on innovative approaches)*	2008	**NRMRL**
APM 207	State-of-the-science report on real time early warning systems for source water protection [EIMS #18560, 18563]	2008	**NRMRL**
APM 208	Determine the fate and transport of NDMA and other disinfection byproducts in aquifer and large multiple-use source waters	2008	**NRMRL**
APM 209	*Evaluate the effectiveness of selected structural Best Management Practices (BMPs) to help macro nutrient balances and sediments in source water turbidity, algae, taste and odor (from Water Quality MYP)*	*2008*	***NRMRL***

DISTRIBUTION SYSTEMS

APG 347 - Provide the Office of Water, states, local authorities and utilities with data and tools for characterizing and managing chemical and microbial contaminants in distribution systems		**2006**	**ORD**
APM	Data to assess the stability of arsenic in water distribution systems *(Also applies to LTG 1, 2006 APG on arsenic implementation)* [EIMS #56082]	2003	**NERL**
APM	Report on chlorine and chloramine to control biofilms in model distribution systems [EIMS #18572]	2003	**NRMRL**
APM	Report on the mechanisms and kinetics of chloramine loss and DBP formation in distribution systems. This work includes modeling the formation of NDMA (n-nitrosodimethylamine) *(Also applies to LTG 1, 2004 APG on DBPs)* (R. Valentine) [EIMS #52287]	2003	**NCER**
APM	Report on the effect of oxidizing conditions on metal releases, corrosion rate and scale properties of distribution system materials [EIMS #29099]	2004	**NRMRL**
APM	Report on studies of biofilm formation rates in pilot scale distribution systems [EIMS #18139]	2004	**NRMRL**
APM	Report on the characterization and prediction of scale formation (including aluminum) in distribution system [EIMS #18500]	2004	**NRMRL**
APM	Report on the detection of opportunistic pathogens (*E. coli*, *Aeromonas*, *Mycobacterium*) in biofilms using molecular detection techniques *(Also applies to LTG 2, 2005 APG on CCL pathogens)* [EIMS #18570]	2004	**NRMRL**
APM 435	Data on the treatment conditions which may enhance the solubilization of arsenic containing iron oxides within the distribution system *(Also applies to LTG 1, 2006 APG on arsenic implementation)* [EIMS #56082]	2005	**NERL**
APM 459	Report on the link between the distribution system and *Mycobacterium avium* complex (MAC) found in clinical cases *(Also applies to LTG 2, 2005 APG on CCL pathogens)*	2005	**NHEERL**
APM 465	Report on characterization of drinking water distribution system biofilm microbial populations using molecular detection methods *(Also applies to LTG 2, 2005 APG on CCL pathogens)* [EIMS #20654, 51701]	2005	**NRMRL**
APM 456	Report on corrosion chemistry relationships and treatment approaches *(Also applies to LTG 1, 2005 APG on Six-Year Review)* [EIMS #18501]	2005	**NRMRL**
APM 492	Report on the impact of change from conventional treatment of surface water to alternative treatment (membrane) on biofilm growth in water distribution systems in support of regulation development [EIMS #18572]	2005	**NRMRL**
APM 374	Improved method for rapid detection of water quality changes *(Also applies to LTG 3, 2006 APG on source water protection)*	2006	**NERL**
APM 366	Leaching studies to characterize organotin concentrations in distribution systems *(Also applies to LTG 2, 2007 APG on CCL chemicals)*	2006	**NRMRL**

APM 381	Update of the EPANET distribution system model	2006	**NRMRL**
APM 334	Report on the association of arsenic with iron particles, corrosion byproducts and sediment in drinking water distribution systems *(Also applies to LTG 1, 2006 APG on arsenic)* [EIMS #29098]	2006	**NRMRL**
APM 360	Evaluate control of *Aeromonas* in distribution systems using chlorine and chloramine *(Also applies to LTG 2, 2007 APG on CCL pathogens)* [EIMS #18575]	2006	**NRMRL**
APM 384	Interim report on management and control of water quality in distribution systems [EIMS #18555, 18556, 18560, 18563]	2006	**NRMRL**

APG 319 - Provide the Office of Water and other stakeholders with new data and tools for monitoring, designing, managing and understanding the risks associated with contamination of distribution systems		**2008**	**ORD**
APM 459	Report on the link between the distribution system and *Mycobacterium avium* complex (MAC) found in clinical cases *(Also applies to LTG 2, 2005 APG on CCL pathogens)*	2005	**NHEERL**
APM 267	Report on studies evaluating distribution system variables associated with microbial health effects	2007	**NHEERL**
APM 237	Comparison of *Mycobacterium* disease isolates and distribution system isolates *(Also applies to LTG 2, 2007 APG on CCL pathogens)*	2007	**NHEERL**
APM 239	Report on biofilm and regrowth issues associated with non-tuberculous mycobacteria *(Also applies to LTG 2, 2007 APG on CCL pathogens)* [EIMS #18577]	2007	**NRMRL**
APM 229	Report on the characterization and prediction of disinfection byproducts in distribution systems *(Also applies to LTG 1, 2010 APG on DBPs)* [EIMS #51973]	2007	**NRMRL**
APM 271	Report on the performance and net cost targets for remote, on-line structural integrity monitoring for drinking water distribution systems [EIMS #20672]	2007	**NRMRL**
APM 210	SYNTHESIS DOCUMENT: State-of-the-science report on management and control of water quality in distribution systems	2008	**NRMRL**

APPENDIX A

Overview of Rules and Statutory Provisions

Arsenic Rule

Arsenic occurs widely in the earth's crust and is a natural contaminant of water. Elevated levels of arsenic in water and soil can be found in certain areas of the U.S. as a result of leaching from rock into ground water and possible geothermal activity. Human health effects associated with exposure to ingested arsenic include skin and internal cancers, cardiovascular disease, cerebrovascular disease, diabetes, and developmental toxicity. In 1975, EPA established an MCL for arsenic of 50 µg/liter under the statutory authority of the 1974 SDWA. As required by the 1996 SDWA Amendments, EPA conducted a reevaluation of this standard and established a new MCL of 10 µg/liter in 2001. The new standard will be subjected to review and possible revision, as necessary, as part of the Six-Year Review process.

The compliance dates for water systems to meet the revised MCL are 2006 for surface water systems and the end of 2007 for ground water systems. Some systems that are unable to meet these deadlines may be eligible for an exemption under §1416 of SDWA, which provides additional time to obtain the resources or take the steps needed to comply with the rule in an appropriate period of time. All public water systems that meet the minimum criteria outlined in SDWA are eligible for an exemption of up to three years. For smaller water systems, exemptions can provide up to nine additional years beyond the compliance date of the MCL to achieve compliance.
(http://www.epa.gov/safewater/arsenic.html)

M/DBP Rules

A major challenge for drinking water providers is to ensure protection against waterborne pathogens while minimizing the potential risks associated with exposure to disinfection byproducts (DBPs). The 1996 Safe Drinking Water Act (SDWA) Amendments established deadlines for a set of interrelated regulations that are intended to address this complex risk trade-off issue. In keeping with a phased M/DBP strategy agreed to by stakeholders and affirmed by the 1996 SDWA Amendments, EPA finalized the *Stage 1 DBP Rule* in November 1998. The Stage 1 DBP Rule established Maximum Contaminant Levels Goals (MCLGs) and Maximum Contaminant Levels (MCLs) for trihalomethanes, haloacetic acids, chlorite and bromate. Maximum Residual Disinfectant Levels Goals (MRDLGs) and Maximum Residual Disinfectant Levels (MRDLs) were established for three chemical disinfectants: chlorine, chloramine and chlorine dioxide. The rule also required certain types of water systems to remove specified percentages of organic materials, measured as total organic carbon (TOC), that may react with disinfectants to form DBPs.

The *Stage 2 DBP Rule*, which was proposed in 2003, is intended to provide additional public health protection from the potentially harmful effects of DBPs. The proposed Stage 2 Rule will retain the Stage 1 MCLs but will include revised requirements for collecting compliance monitoring data and calculating compliance. The proposed rule also requires an initial distribution system evaluation to identify compliance sites that reflect locations with the highest

DBP occurrence levels in the distribution system.
A series of microbial rules is being developed and implemented concurrently with the DBP rules. The first of these rules, the *Interim Enhanced Surface Water Treatment Rule (IESWTR)*, was finalized in December 1998. The IESWTR amends the 1989 Surface Water Treatment Rule to strengthen microbial protection and to address risk trade-offs with DBPs. Key provisions include treatment requirements for *Cryptosporidium* for filtered water systems, tightened turbidity standards, and inclusion of *Cryptosporidium* in the watershed control requirements for unfiltered public water systems. In January 2002, EPA finalized the *Long-Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR).* This rule extends the provisions of the IESWTR to cover all system sizes, particularly those serving <10,000 individuals. The LT1ESWTR improves control of *Cryptosporidium* in drinking water and addresses risk trade-offs with DBPs. The next generation of surface water treatment rule, the *LT2ESWTR*, is scheduled to coincide with the proposal and promulgation of the Stage 2 DBP Rule.
(http://www.epa.gov/safewater/mdbp.html)

The *Ground Water Rule (GWR)* is a targeted strategy to identify ground water systems at high risk for fecal contamination. The GWR establishes a multiple barrier approach to identify and provide corrective measures for public ground water systems at risk of fecal contamination. The GWR is scheduled to be issued as a final regulation in 2003.
(http://www.epa.gov/safewater/gwr.html)

Six Year Review
The 1996 SDWA Amendments require EPA to review each National Primary Drinking Water Regulation (NPDWR) at least once every six years and revise them, if appropriate. SDWA specifies that any revision must maintain or increase public health protection. In consultation with stakeholders, EPA developed a systematic approach for the review of the NPDWRs. This protocol was applied to the Agency's initial Six-Year Review of most of the NPDWRs published prior to the 1996 SDWA Amendments (i.e., pre-1997 NPDWRs). In 2002, EPA announced preliminary revise/not revise decisions for 68 chemical NPDWRs and the Total Coliform Rule (see a description of this rule as it relates to distributions systems at the end of this section). EPA requested public comment on these preliminary determinations and on the protocol used to conduct the review. Final revise/not revise decisions were published in 2003. The Six-Year Review requirements also apply to the other EPA regulations discussed in this Appendix, The timing of these reviews will be determined based on their respective promulgation dates.
(http://www.epa.gov/safewater/review.htm)

Unregulated Contaminants - The Contaminant Candidate List (CCL)

The 1996 SDWA Amendments require the EPA to establish a list of unregulated microbiological and chemical contaminants that may be regulated by EPA at some future date. Regulatory determinations must be made on at least five contaminants on the list every five years. The list, referred to as the Contaminant Candidate List (CCL), was first published by EPA in 1997 and finalized in 1998 (EPA, 1998b) after extensive consultation with stakeholders. In establishing

the CCL, EPA divided the contaminants into three major categories: 1) a Regulatory Determination Priorities Category, with contaminants that have enough data to determine whether a regulation is necessary; 2) a Research Priorities Category, which contains contaminants with additional research needs in the areas of health effects, treatment, and/or analytical methods; and 3) an Occurrence Priorities Category, with contaminants for which additional occurrence data are needed. The 1998 CCL includes 50 chemicals and 10 microbial pathogens, most of which are in the Research and Occurrence Priorities Categories. For each contaminant on the CCL, the Agency will need to obtain sufficient data to conduct analyses on the extent of occurrence and the risk posed to populations via drinking water. This will ultimately lead to an appropriate Agency action for that contaminant -- regulation, guidance, or a decision not to regulate.

In 2002, EPA announced a preliminary regulatory determination that no regulatory action is appropriate or necessary for nine contaminants on the first CCL. These contaminants include: *Acanthamoeba*, aldrin, dieldrin, hexachlorobutadiene, manganese, metribuzin, naphthalene, sodium, and sulfate. A final CCL regulatory determination was published in 2003.

The next CCL will be published in 2003, and a new CCL list will be published every five years thereafter. For the 2003 CCL, the starting point will be the list of contaminants from the previous CCL where a regulatory determination has not been made. EPA, with guidance from the National Academy of Sciences and the National Drinking Water Advisory Council, is developing a more rigorous process for selecting contaminants for future CCLs. (http://www.epa.gov/safewater/ccl/cclfs.html)

Source Water Protection

Protecting sources of drinking water before contamination occurs offers a common sense approach to maintaining the quality of drinking water and safeguarding public health. Source water protection is an ongoing process that includes conducting assessments to understand the vulnerabilities of the source to contaminants, monitoring to detect contamination as early as possible, protecting and treating sources using Best Management Practices (BMPs), and planning for quick response when contamination occurs.

SDWA includes important provisions that require or otherwise promote actions at the national, state and local levels to protect source waters from contamination. The 1996 SDWA Amendments require states to develop and implement Source Water Assessment Programs (SWAPs) to analyze existing and potential threats to the quality of the public drinking water throughout the state. The national Wellhead Protection (WHP) Program, established under the 1986 SDWA Amendments, is a pollution prevention and management program used to protect underground sources of drinking water. States may use the funds from the SDWA-authorized Drinking Water State Revolving Fund (DWSRF) set-asides to support a mixture of source water-

related local assistance activities. Other statutory authorities, particularly the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) support source water protection activities. For example, the Clean Water Action Plan is a CWA program that represents an effort by nine federal agencies to develop and implement a comprehensive plan to protect water resources by targeting watershed protection efforts in high priority areas. The Action Plan also provides communities with new resources to control polluted runoff and enhance natural resource stewardship. The CWA also authorizes the Clean Water State Revolving Fund, which provides resources for communities, water systems, and other organizations (including land conservation associations), for projects that protect source water and enhance water quality. (http://www.epa.gov/safewater/protect.html)

Distribution Systems and the Total Coliform Rule

Post-treatment water quality degradation in aging water distribution systems is already a significant problem that is likely to get worse over time. In the U.S., 24% of the waterborne disease outbreaks reported in community water systems over the past decade were caused by contamination of the water distribution system. This estimate provides only a limited basis for assessing the potential public health risk posed by contamination of the distribution system due to such causes as cross-connections and backflow, intrusion, and biofilms. Based on data from 1993 to 1996, the American Water Works Association estimated that water main breaks occur at a rate of approximately 75,000/year. Approximately 26% (about 220,000 miles) of distribution system pipe is unlined cast iron and steel and is in poor condition. Even in a distribution system with good structural integrity, water quality degradation may occur if the distribution system is designed, constructed, operated, or maintained in a manner that promotes excessive microbial growth or chemical formation and migration.

These concerns have been raised in the context of the SDWA-required Six-Year Review of the Total Coliform Rule (TCR), which was promulgated on June 29, 1989. The TCR requires all public water systems (PWSs) to monitor for the presence of coliforms in their distribution systems, as measured by "total coliforms."

The Microbial and Disinfection Byproducts (M/DBP) Federal Advisory Committee (FACA) agreed in principle that valid health concerns from distribution systems exist. The committee recommended that EPA should review available data and research on distribution system risks, and work further with stakeholders. These efforts will result in the review and possible revision of the TCR, as well as the potential for requirements to address finished water quality in the distribution system.

EPA, in association with distribution system experts, has developed a series of "white papers" that provide background information on nine distribution system issues. These papers and additional information on the Six-Year Review of the TCR can be found at the URL below.

(http://www.epa.gov/safewater/tcr/tcr.html)