UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

September 1, 2009

EPA-SAB-09-016

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Consultation on the Aging Water Infrastructure Research Plan and Program

Dear Administrator Jackson:

EPA's Office of Research and Development (ORD) Research Plan on Aging Water Infrastructure (AWI) describes a large number of projects intended to improve and evaluate innovative technologies and techniques to reduce the cost and improve effectiveness of aging drinking water and wastewater treatment and conveyance systems. After finalizing the plan in 2007, ORD commenced twenty six research projects that constitute only a subset of projects recommended in the plan. ORD requested that the EPA Science Advisory Board (SAB) provide early advice in the form of a consultation on the suitability and appropriateness of completed, existing and upcoming research projects, whether additional projects are needed, and the overall scope of the program.

An SAB consultation is a mechanism to provide individual expert comments for the Agency's consideration early in the implementation of a research or other program. A consultation does not require consensus among the Committee members nor preparation of a detailed report. The SAB Committee is pleased for this opportunity to provide input to ORD's critical work on aging water infrastructure at these formative stages. The SAB Environmental Engineering Committee (EEC) augmented with additional experts held a public meeting on July 21-22, 2009 to provide a consultation for ORD about its AWI research plan and program.

Overall, ORD is doing an excellent job on this vital topic with limited funding and resources. ORD has managed its limited resources well, the AWI research program has been carefully planned, has already developed useful results, and is well poised for impact. The program is focused on an area of critical national importance and the SAB Committee members applaud the EPA for the resources being devoted to this effort. The Committee members also recognize that the AWI research program is just the initial part of what will be a sustained effort by ORD to help address the nation's large AWI renewal challenge. While the ORD effort to re-establish leadership in water technology research and development is most certainly good for the

nation, the current research program is small relative to the challenge our nation faces. ORD's annual budget for research on this topic is $5 million between 2007 and 2012, a small amount relative to the magnitude of the infrastructure renewal need which is in the hundreds of billions of dollars. In order to help transform the nation's water infrastructure in the 21st century, ORD needs to continue its focus on the most pressing AWI research questions.

At the public meeting and in individual written comments, the Committee members suggested various improvements to the overall research program approach and to individual ongoing ORD research projects. The members also provided recommendations for leveraging available funds, improving and increasing the number of partnerships, and enhancing communications and program interactions with appropriate stakeholders. As Chair of the EEC, I identified several key points made by Committee members during the consultation meeting in response to the Agency's charge. These key points as well as individual written comments from Committee members in response to ORD's charge questions are appended in Enclosure 2.

The Committee would like to thank the EPA presenters and participants at the consultation for their expertise, perspectives, and insights which greatly assisted the Committee's understanding of the AWI research program. We hope that the comments and recommendations of the EEC are helpful to EPA as the Agency continues the important work of the Sustainable Water Infrastructure Initiative and its AWI research. We look forward to further engagement with ORD in discussing the progress ORD has achieved in its aging water research program.

Sincerely,

/Signed/

Dr. David A. Dzombak, Chair
Environmental Engineering Committee

cc: Dr. Deborah L. Swackhamer
Chair, Science Advisory Board

Enclosures:

Enclosure 1: Committee Roster
Enclosure 2: Comments from Committee Members
Enclosure 3: EPA Charge Questions to the Committee

Enclosure 1
Committee Roster

U.S. Environmental Protection Agency
Science Advisory Board
SAB Environmental Engineering Committee (EEC) Augmented to Provide Consultative Advice on EPA's Aging Drinking Water and Wastewater Infrastructure Research Initiative

CHAIR

Dr. David A. Dzombak, Walter J. Blenko Sr. Professor of Environmental Engineering, Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh PA

MEMBERS

Dr. Viney Aneja, Professor, Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC

Dr. John C. Crittenden, Director of the Brook Byers Institute for Sustainable Systems, Hightower Chair and GRA Eminent Scholar in Sustainable Systems, and Professor of Civil and Environment Engineering, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA

Dr. Cindy M. Lee, Professor, Department of Environmental Engineering and Earth Sciences, Clemson University, Anderson, SC

Dr. Reid Lifset, Associate Director of the Industrial Environmental Management Program and Resident Fellow in Industrial Ecology, School of Forestry and Environmental Studies, Yale University, New Haven, CT

Dr. James R. Mihelcic, Professor, Civil and Environmental Engineering, State of Florida 21st Century World Class Scholar, University of South Florida, Tampa, FL
Dr. Horace Moo-Young, Dean and Professor, College of Engineering, Computer Science, and Technology, California State University, Los Angeles, CA

Dr. Catherine A. Peters, Associate Professor, Department of Civil and Environmental Engineering, Princeton University, Princeton, NJ

Dr. Mark Rood, Professor, Department of Civil and Environmental Engineering, University of Illinois, Urbana, IL

Dr. John R. Smith, Division Manager, Environmental Science and Sustainable Technology, Alcoa Inc., Alcoa Center, PA

Consultants

Mr. John Colbert, Manager, Maintenance, Metropolitan Field Operations Department, Massachusetts Water Resources Authority (MWRA), Boston, MA

Mr. Larry Jaworski, Vice President, Black & Veatch Inc., Gaithersburg, MD

Mr. Larry Johnson, Assistant Department Director for the Water Utilities Department, Palm Beach County, West Palm Beach, FL

Ms. Liliana Maldonado, Senior Vice President and Northeast Regional Manager, CH2M Hill Inc., Chantilly, Virginia

Mr. Michael Selna, former Assistant Chief Engineer/General Manager, Los Angeles County Sanitation Districts, Whittier, CA

Dr. Vanessa Speight, Associate, Malcolm Pirnie Inc., Arlington, VA

Dr. Michael K. Stenstrom, Distinguished Professor, Civil and Environmental Engineering Department, University of California at Los Angeles (UCLA)

SCIENCE ADVISORY BOARD STAFF

Mr. Edward Hanlon, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board Staff, Washington, DC

Enclosure 2: Comments from Committee Members

Summary of Key Points of Discussion By Committee Chair, Dr. David A. Dzombak

In concluding discussions at the July 21-22, 2009 Consultation, the Chair identified several key points made by Committee members for ORD's consideration as it assesses its AWI research program. Those key points are summarized below. The individual Member comments (Enclosure 3) provide specific suggestions to improve the AWI research program.

Charge Questions 1 and 2: Focus and Goals of the AWI Research Program:

1) The goals of the AWI research program are clearly stated, and the research focus areas are appropriate and well oriented toward achieving the program goals. EPA is reestablishing its leadership role on AWI that it held in the 1970s when the EPA had a critical role in building national technical and human resource capacity to meet the goal of secondary treatment of municipal wastewater. Now that there are secondary treatment plants throughout the nation, the focus on renewing and advancing the water infrastructure of the nation is an especially important undertaking. ORD has a key role in formulating and conducting AWI research.

The cost of addressing AWI issues over the next twenty years is more than several hundred billion dollars, and the AWI technology research and development (R&D) budget of approximately $5 million/year to address these issues is very modest. To best utilize scarce R&D resources to achieve safe water supply and effective wastewater management at a significantly reduced cost, it is important that efforts in the AWI program be leveraged as much as possible. Also, the AWI research program should be planned and conducted with an eye toward creating initiatives that can live on after the program concludes.

2) The AWI research program activities have potential for significant national impact, but will require careful planning as the program expands beyond its early phases. The potential for national impact will be significantly enhanced by bringing together technological, economic and social components required for successful assessment, rehabilitation, and upgrading of water infrastructure. Demonstration projects offer a good opportunity for such integration. Geographic diversity should be considered carefully in selection of the projects. Through careful selection of demonstration projects that will benefit water infrastructure organizations nationwide, and investigation of the full range of aspects that determine project success (particularly those that are structured to have a total water management approach), model approaches for water infrastructure renewal will be identified. Integrated results of such projects would be examined with interest by many communities throughout the nation. One way to encourage integration is to develop a roadmap or decision tool to be used by respective stakeholders and decision makers so that the most cost-effective total water management approach is developed for a particular situation.

3) AWI research focus areas and projects, and the explicit inclusion of the Advanced Concepts focus area, provide a clear mandate to be forward looking in a portion of the program. Several specific suggestions for modifying the process and activities of ongoing projects, potential additional focus areas including condition assessment and rehabilitation methods, and methods for identifying projects that have a high probability of success, are provided in the individual Member comments (Enclosure 3).

The AWI program leaders are strongly encouraged to aim for water infrastructure transformation and not just repair of 20th century systems. As a nation, we should take advantage of investments in AWI assessment and rehabilitation work, and look for opportunities to implement truly innovative, transforming approaches in order to help move us to a new 21st century water infrastructure. The need for a greater emphasis on transformation in various AWI topic areas was discussed, including energy conservation, energy and nutrient recovery from wastewater, new materials for conveyance and distribution systems, new approaches to stormwater management, methods to address and adapt to climate change, planning towards a total water management approach, enhanced use of life cycle assessments, consideration of social, economic and political issues when determining how to address AWI problems, methods for reuse and reclamation of treated water, cyberinfrastructure, updating design standards and development of design manuals, methods to address issues on private property, and development of tools to guide us towards routine application of green engineering principles in both urban and rural settings.

An outcome of the AWI program could be components of a vision that ORD could develop for the year 2025 that describes water infrastructure goals and actions, and how the nation will achieve these goals. A clear strategic focus is needed for the AWI program to help guide the nation's AWI industry towards these goals. The strategic focus could articulate whether the goals for wastewater and stormwater management are primarily to continue to enhance the central treatment system approach and fix/upgrade the current piping infrastructure, or whether the goals are primarily to begin to look at greener approaches for management of these systems.

ORD's cross-cutting AWI research projects provide a vital foundation for the technological leadership that ORD will provide in the future. EPA should develop measures to help gauge the degree to which innovative and cross-cutting technologies are being adopted. In addition, technical staff at utilities need information on reasonable expected AWI costs, costs vs. benefits of new technologies, and other resources that would help convince their management to support AWI maintenance programs. Measures to track the extent to which infrastructure rehabilitation and renewal is being achieved relative to need would also be helpful.

4) Much related work has been done or is ongoing at water and wastewater utilities, other government agencies, and other programs within EPA. It is very important that ORD not repeat such work and that ORD's AWI research program build on and leverage these activities, particularly those involving full-scale demonstration, to efficiently use limited resources and enhance national impact. The Water Environment Research Foundation (WERF) and the Water Research Foundation (WRF) have information on opportunities to leverage with particular wastewater and drinking water utilities. The potential for national impact would also be enhanced by having geographic diversity in the locations of upcoming demonstration projects.

ORD should try to collect and disseminate data on ongoing or completed large-scale projects (several are noted in member comments within Enclosure 3). ORD is encouraged to develop accessible databases of demonstrated AWI case studies, technologies and tools that improve cost effectiveness of AWI operation and maintenance.

5) As discussed below under the key points regarding Charge Question 5, Engagement with Stakeholders, AWI leadership should think carefully about target audiences for the various activities and projects of the program. It is important to identify those audiences that provide the

best opportunity for education and information transfer to the practitioner so that program activities will have national impact. This is important for all program components, and will be especially important for the most forward looking activities such as those pertaining to total water management (which most utilities are not well positioned to address).

Charge Question 3: Appropriateness of ORD's Sequential Research Approach:

1) The sequencing approach is well thought out and appropriate in relation to the program goals. Some activities can be, and are being, done in parallel. ORD and the AWI program should continue to think about opportunities for parallel work as efforts move into demonstration phase, such as the ongoing evaluation of the state of technology. Several specific suggestions for improvements to each of the three phases of work (assessments, state of technology reports, and pilot/full scale demonstrations), and for flexibility in the application of ORD's sequential research approach, are provided in the individual Member comments (Enclosure 3).

2) Pilot tests should be conducted before full-scale demonstration tests are undertaken. This will enable the most productive use of demonstration project funding, and will help ensure the best chance of success for promising technologies. Access to some types of pilot facilities will be possible under the new cooperative agreement that EPA ORD has recently formed with the Water Environment Research Foundation (WERF) and the Water Research Foundation (WRF). The demonstration projects need to be well-designed, and should be selected to fill gaps that have not already been addressed by utilities and other local, regional, national and international organizations.

3) EPA is uniquely positioned to meet a significant national need with respect to water infrastructure renewal. EPA's efforts can include synthesis of data and information already being collected or could be voluntarily generated by utilities, communities, and private organizations on the pilot and full-scale performance of materials, treatment processes, conveyance systems, technologies, and other aspects of the AWI program. Collection, synthesis, and dissemination of such information is critical to advancing the state of practice. In particular, targeted dissemination of assessments and state of technology reports would have lasting beneficial effects. No other organization in the U.S. has the reach and credibility of EPA to meet this need. EPA should consider how to collect, organize, and make such information available to the public and target audiences in a practical way.

4) For work done in all phases of the AWI research program, the delivery of the products should be designed so that they can be updated or augmented in the future where feasible. The challenge of water infrastructure renewal will be with us after the AWI research program concludes in five to seven years. It will be beneficial to the nation if program results are developed in a way that can be updated.

5) Another ingredient that is important for national impact is continuous contact with States and EPA Regional offices, particularly the water permit writers, to learn about water infrastructure experiences and needs in different parts of the nation and to share AWI information and data on a continuous basis. ORD's AWI research staff are in regular contact

with States and EPA Regional offices for various reasons. Interactions with States and EPA Regions might be systematized and described in the AWI program description.

Charge Question 4: Collaboration with Research Partners:

1) The range and diversity of partnerships established in the AWI program is impressive. These commendable partnerships have clearly been developed with careful thought, and will benefit the program and extend its impact.

2) Many specific suggestions for other potential partners that may be useful for the AWI research program are provided in the individual Member comments (Enclosure 3), and include organizations involved with water system cyberinfrastructure, water reuse in agriculture, stormwater authorities, green buildings, State regulators, and climate change adaptation. Also, ORD should consider ways to strengthen its ties to State transportation agencies, Non-Government Organizations, the Association of Environmental Engineering and Science Professors, and other programs and offices within EPA (e.g., EPA's Environmental Technology Verification (ETV) Program, ORD's Sustainable Technology Division (STD), the Office of Water (OW), and the Office of Enforcement and Compliance Assistance (OECA)). The prioritization and definition of specific and tangible goals for each partnership would help maximize the reach of the AWI research program.

3) There has been little research funding available from federal agencies, industry, or private foundations for water and wastewater infrastructure and conveyance systems over the past 20 years. A sustained program for research in the area of water infrastructure will provide a reservoir of expertise in academia, and assist in the development of innovative technology in this field.

Charge Question 5: Engagement with Stakeholders:

1) The comprehensive communication plan that ORD has developed for the AWI program is impressive. The plan is well formulated and could serve as a model for other programs within ORD.

2) An aggressive and sustained communication and dissemination program is critical to maximizing the national impact of the AWI program. While the program was initiated only two years ago, it is largely unknown in the community of water infrastructure practitioners, educators, and planners. This must change if important program results are to be known broadly. To this end, a number of suggestions for enhancement of the communication program are summarized below, and more specifically articulated in comments from individual Members (Enclosure 3).

3) The suggested communication program should be designed to address three distinct tasks: (a) get attention for the AWI program; (b) make information accessible and searchable; and (c) encourage adoption of successful and cost effective technologies and practices related to

water infrastructure assessment, rehabilitation, and renewal, and receive feedback from users who adopt AWI technologies and practices.

- To accomplish these tasks and obtain significant national impact for the AWI program, target audiences need to be carefully considered. A key element for successful outreach will be to tailor the technology transfer to the specific needs of the stakeholder group. Audiences with the greatest potential for advancing technology should be identified and targeted. Such audiences would include State and EPA Regional regulators whose decisions determine the pace of technological innovation in water infrastructure engineering, small business, small, medium, and large-sized utility operators, and the construction and architectural/engineering industry. Audiences within EPA are also important, including technical and regulatory staff within OW and OECA.

- Dissemination of results to the practice and education communities is important. Past experience in wastewater treatment engineering and remediation engineering has shown that EPA can have a powerful influence on advancing the state of practice through development and aggressive, creative dissemination of technical guidance documents and manuals. Online/distance education, workshops, webcasting, podcasting and publishing of success stories in peer reviewed journals are among the suggested mechanisms for ORD to reach its stakeholders. Successful dissemination vehicles developed by the EPA in other technology domains can be emulated, such as the EPA CLU-IN web site, the EPA Tech Direct email newsletters and webinars, and the one-day free or low cost seminars and training that EPA has offered on a variety of topics. Exploitation of new technologies for dissemination such as podcasts and YouTube videos should be explored. Collaboration with professional organizations such as the Water Environment Federation (WEF), the American Water Works Association (AWWA), and the American Academy of Environmental Engineers (AAEE), which have well established and continuously evolving communication mechanisms, is recommended.

- Train-the-trainer programs are needed. Training programs aimed at educating university faculty members and other trainers need to be developed and conducted. Opportunities for using the cooperative agreement with WERF and WRF to expand such dissemination and communication offerings should be explored.

- The effectiveness of the communication plan and the extent of its reach should be assessed to help improve it on a continuing basis. One approach that can help with such assessment is introduction of two-way communication vehicles to allow collection of feedback from users on what outreach and dissemination approaches are successful and unsuccessful, and what approaches should be pursued. EPA should develop measures to help identify such effectiveness.

- The existing communication plan is comprehensive and well formulated, but an even stronger plan is needed to maximize the national impact. Development of particular objectives and targets for impact in the form of a “roadmap” for the communication effort will help devise enhancements to the communication plan. The AWI program is encouraged to develop these objectives and targets.

Comments from Dr. Viney Aneja

The augmented EEC Committee of the US Environmental Protection Agency's Science advisory Board met in Cincinnati, OH, on July 21 and 22, 2009 to deliberate on the US EPA's Aging Water Infrastructure Research program. Specifically the EEC was tasked to provide advice on whether the program goals, research focus areas, research approach, research partners, and communications and program interactions are properly directed to have a significant national impact of the major technical issues facing our nation's aging water infrastructure. More specifically, I was requested to address the following charge (4 and 5) questions:

4. Are we collaborating with the appropriate research partners? Are there other potential partners that we should engage?

5. Through our communication and program interactions, are we engaged with the appropriate stakeholders to understand the research needs in this area, attain the goals of the program and to transfer the research and technology demonstration results to the appropriate users?

Response:

General comments

I was very impressed with the diversity (different scientific and technical backgrounds) and the intellectual strength of the committee. I was equally impressed with US EPA's breath of collaboration, range of partnerships, and judicious use of leveraged funds.

Specific Comments

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

I raised three issues which are ignored in both the staff presentations and background documents provided; and encouraged that they be brought to the 'table':

(i). While range of partnerships is very impressive, US Department of Agriculture and Agricultural industry are not being partnered with. Agriculture sector (both crop and animal) play a very important and significant role in the nation's surface and ground water supply; including the arena of water reuse. Agriculture uses variety of chemicals e.g. nitrogen as fertilizer, pesticides, insecticides, and antibiotics (in animal agricultural production). All these have document consequences in the nation's water supply.

(ii). Climate Change and impacts on water (e.g. rainfall etc.) due to climate change.

(iii). Partnerships with NGOs. Variety of advocacy groups (e.g. Environmental Defense Fund) have started to play an important and constructive role in these kind of issues, and US EPA could take advantage of their expertise in outreach related activities.

Charge Question 5: *Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.*

The committee applauds the detailed thought provided by US EPA in the communication and outreach related issues. I raised and suggested a few issues as follows:

(i). What are the impacts of this program, and how will they be documented; and how will US EPA measure success of the program.

(ii). The challenges that confront US EPA in transitioning the technologies being developed as part of this program to the end user e.g. the utilities.

Comments from Mr. John Colbert

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

The focus of the research in the report is on buried infrastructure. The buried infrastructure at most utilities is the oldest assets and more attention needs to be devoted to ensuring they are properly maintained and replaced. But utilities also own equipment assets and buildings that need to be maintained and repaired and replaced appropriately. The replacement cost of equipment assets at my utility is approximately equal to replacement cost of our buried assets. Utilities need to adopt asset management including planning and scheduling, cross functional flexibility, preventive maintenance optimization, and condition monitoring. The use of condition monitoring techniques such as vibration, acoustic ultrasonic, and oil analysis provides cost savings so that minor repairs can be made instead of major replacements. In addition condition monitoring tracks the health of equipment so that repairs can be planned and budgeted. Another equipment example is the longitudinal chain at Deer Island was starting to fail after 10 years of service. Samples of the chain had been sent out for material analysis a regular basis so the 403SS chain replacement could be planned appropriately. The MWRA investigated what type of replacement chain would provide a longer service life. Working with the chain manufacturers and from some field testing, the MWRA elected to use a 304SS chain which is used extensively in Japan but not in the US. This is a $50M project as both primary and secondary chain will be replaced over the 3 year installation period. This is an example of performing condition assessment and LCCA analysis to determine the most effective project to move forward for an equipment replacement.

The addition of equipment assets to the program may be of help. Note that WERF 02-CTS-20CO, Condition Assessment Protocols including both buried assets, facility assets, and equipment assets.

Charge Question 2(A): Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

The document prepared for Aging Water Infrastructure Research Program is an excellent document that is well organized, written, comprehensive and well thought out. I believe that the research for condition assessment identified will met the goal to provide tangible outputs and outcomes that will support Aging Infrastructure Research Program.

The presentation by Mr. Daniel Murray concerning the SSO Analysis and Planning Toolbox (SSOAP) program could be helpful to utilities. The use of flow meter data, rainfall data and tidal data and there impacts on collection system flow can be of great use. At the MWRA a recently installed SCADA system for all wastewater stations has provided more data for operations staff to better handle rain events. Engineering at the MWRA using the SCADA facility data, flow data, and rainfall is attempting to find correlations to better control our collection system using our hydraulic model. Real time control including rainfall data and modeling information could

be of great benefit to utilities for operations to identify areas where inflow and infiltration are occurring.

Concerning the wastewater collection report assessment and water distribution condition assessment I have comments the individual research projects proposed. The research starts with reviewing what technologies currently are used, what new technologies are available and can be tested and forecasting pipe lifespan. Starting with wastewater collection my comments are:

1. Optimizing of Internal Camera Inspection Data and Information for Effective Condition Assessment (12-15 months) – This project is needed to take camera data and make effective use of inspections to determine pipe condition. The MWRA currently uses a qualitative rating of A, B or C although we are moving now to use the National Association of Sewer Service Companies NASSCO rating system. Improvements in how to categorize the inspection data for better condition assessment would be helpful to compare pipe condition assessment data from different utilities.

7. Asset Management Guidance and Tools for sewer inspection prioritization based upon risk. A guidance tool will result in cost savings for utilities will be very useful. At the MWRA for many years' staff completed TV inspections on a regular schedule and only a few projects were added to the Capital program for pipe replacements. The MWRA then developed a risk based methodology to prioritize our pipe replacements and a fully developed spending plan was developed and added to our capital budget. Addition tools to prioritize pipe replacements and inspections will be of great help to all utilities. The gas pipeline industry completes similar risk assessments and it may be helpful for this project if the gas industry methods were researched for additional insights.

The only issue with completing risk assessments is if utilities need to have sufficient engineering resources available to complete this work. Most large utilities do have the resources to undertake this effort while smaller utilities will not.

2. Emerging and Innovative Technologies for the Inspection of Wastewater Collection Systems and
4. Cross Sector Transfer and Application of Advanced and Remote Sensing Technologies for WW Collection System Monitoring

If emerging technologies can assess qualitatively the condition of wastewater collection piping these two projects could have the most impact for utilities. Inspection results that provide good data that piping is close to failure or is in good condition provides management with the information to make the right decisions if to forward with capital projects. Better technology of buried pipe condition is needed. The use of demonstration projects of new technologies will speed the implementation of these technologies at utilities.
For equipment assets the number of condition monitoring tools is extensive including vibration, infrared themography, acoustic ultrasonics, electrical testing, motor current signature analysis, and oil analysis. Similar tools are needed to provide better information on the health of collection system piping.

If remote sensing of pipe condition can be developed that are cost effective that will be another benefit. It is currently labor intensive for staff to TV inspect wastewater piping.

3. Advanced Techniques for Detecting Exfiltration and Crown Corrosion Conditions – Again any tool that can assist in determining the condition of a portion of the collection system is needed. If an advanced technique to detect crown corrosion can be developed it would be of help.

7. Understanding the Forensics of Sewer Failures to Support Failure Forecasting Model Development – This project looks at sewer failures to model and forecast future failures to support risk analysis. Tools to forecast failures to assist in replacement planning will be of help to utilities. At the MWRA we looked at all of our failures and only could correlate between pipe condition, type of piping installed, and age. If additional research could identify any other critical factors to consider it could assist in a risk model.

Condition Assessment of Water Distribution Systems

1. Decision Support Evaluation and Improvement – this project has three goals including determining when condition assessments are cost effective , setting priorities for research, and improve the availability of condition assessment data by developing an utility database.

2. Condition Assessment Technology Performance and Cost – This project is to evaluate and demonstrate condition assessment technologies, evaluate metrics for performance and cost, and develop design standards for new installations for ease of inspection. This project will be of great benefit to utilities if new technologies can be developed to improve the knowledge of the water distribution system health. This is a key research component and the technology demonstration in Louisville and leak correlator technology using the leak detection experimental station are both great opportunity to assist utilities.

In addition to assessing the condition of piping any new technology to locate buried water distribution piping would be of assistance for older piping systems. It is important for utilities to know exactly where pipes are located to use the condition assessment equipment. For new pipe systems we locate all piping using GIS coordinates.

3. Causes, Mechanisms and Predictability of Failure to Enhance Condition Assessment Capability – This project which will assist utilities in planning pipe replacements by providing failure mechanisms and developing decay curves.

To summarize, new cost effective tools for condition assessment of wastewater collection and water distribution piping, ensuring the data is incorporated into risk models is needed, and development of data to predict failures are needed to ensure that capital spending is correctly spent.

<u>Charge Question 2(B):</u> Comment on whether research on system rehabilitation will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

No research projects are listed for manhole/appurtenances although the report states 30 to 50% of infiltration is through manholes. Could this research be added to the Rehabilitation of Lateral Research project?

Charge Questions 2(c) and (d):

Charge Question 2(c): Comment on whether research on advanced concepts and innovative treatment technologies will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

Charge Question 2(d): Comment on whether the cross-cutting, integrative research on water infrastructure will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals.

No comments

Charge Question 3: Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

The research is well planned and developed to review current and analyze current technology. The research first reviews existing technologies and then moves to investigate new methods/techniques for improvements. The first step should be to get existing utility best practice information out to all utilities through either workshops or other communication methods. The information must be presented in a way so that utilities will not only learn about best practices but implement the best practices presented.

The demonstrations will be very helpful for utilities to identify technologies that work. Utilities need proof that a new technology will provide a benefit over existing technologies currently being used before investing in the new equipment and staff time and training. The water technology demonstration is a great start and if several technologies perform well in the testing it will encourage utilities to implement the new technology.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

Other research partners –

DOT is listed as a partner that regulates gas pipelines. Gas pipelines are a similar utility to water distribution and wastewater collection piping and have many of the same issues including completing risk assessments, locating piping, high consequence areas, and leak detection. The gas industry is also heavily invested in cathodic protection to protect buried piping from corrosion. Partnering with the gas pipe industry may have many benefits. NACE (National Association of Corrosion Engineers) provides the certification for all cathodic test personnel and is another trade group that has a lot of experience providing protection of buried infrastructure.

Other partners that may be considered are the Instrumentation and Control Engineering Society (ICE) for all instrumentation issues (see public comment by Joel Ducoste).

Public Comment – Duncan Rose – Australian Research Council (ARC) project includes two projects 1) Optimal management of critical pressurized mains using advanced failure prediction

and 2) cost-effective condition assessment and smart decision guidance frameworks. The condition assessment piece includes research on soil corrosivity, pipe and soil backfill conditions, improving condition assessment tools and estimation, prediction of water pipe failures, and knowledge management and guidance. These research topics are included in many of the EPA research plans.

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

ORD is engaged with appropriate stakeholders. One good way to transfer the results to utility staff would be similar to the approach EPA used to introduce asset management through workshops. Steve Albee from EPA, one US utility, one Australian asset management consultant, and one US asset management consultant made the presentations. The workshops were low cost, 2 days, and many utilities and staff attended. These workshops were a great way to disseminate the information to small to large utilities.

In addition, webcast also are very helpful to disseminate information. These work well to reach out to all utilities when using the local Water Environmental Foundation (WEF) mailing list to organize. NEWEA (New England Water Environmental Association) has organized several webcasts on asset management.

Comments from Dr. John C. Crittenden

The aging infrastructure research is incremental and not sufficiently transformative. I truly believe these support activities will get done with or without EPA support. I believe that formulating markets through regulation would accomplish more. For example, if we passed a regulation that you must inspect 10 % of your distribution system per year this would stimulate the market and this may cause the private sector to develop appropriate technologies.

Also when is it appropriate to abandon aging infrastructure and start with a new approach. For example, distributed systems may be more sustainability and resilient. EPA should consider looking at the water energy land use nexus. These are related. Distributed storm water treatment could be used to create green areas and this would increase real estate taxes and eliminate combined storm water and waste water collection systems. Distributed energy and water production could result in more resilient systems. The waste heat could be used to heat buildings and provide hot water depending on the manner in which the community is designed. Distributed water treatment systems that provide water to smaller distribution systems with shorter detention times could result in much higher quality water at the tap. Separate lines for drinking water and toilet flushing also could provide many benefits.

We should also look at waste water as a resource and carefully consider integrated resource recovery. Waste water contains energy and nutrients. Research has begun on recovering ammonia and phosphate from urine and this may be a useful strategy when you consider the energy required to fix nitrogen (for nitrogen fertilizers) and we may run out of minable phosphate in 100 years. This discussion is really about knowledge transfer and a paradigm shift in the manner in which water is provided and treated. This is not really research but it important to consider.

The aging infrastructure activity does not contain any research on sustainability or resiliency. There is no life cycle assessment analysis that would compare different strategies for replacing ageing infrastructure. This would guide us as to when the infrastructure should be replaced and what should replace it.

The fundamental problem is that revenue from water bills pay only a fraction of the cost of water provision and waste water collection. The difference is made up from other tax revues. If consumers paid the true cost, conservation would be occur. However, it is not up to EPA to intervene in this local government process, but some of my recommendations do go require unfunded mandates.

Comments from Mr. Larry Jaworski

Once again I want to express my appreciation for the opportunity to have been involved in the recent AWI Consultation. I enjoyed the dialogue and appreciated the effort and input by ORD prior to and during the meeting.

Each member of the Consultation was invited to submit written comments for the record with a specific focus on those "charge questions" on which the member was involved. Here are my comments:

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

I would suggest that ORD also devote effort to identifying updated design standards for our nation's infrastructure. In some cases we are still designing water and sewer infrastructure using guidelines and rules of thumb developed in the early 1900's. If we are to turn-the-tide of aging infrastructure we need to come up with new ways of designing and implementing our nation's infrastructure.

Charge Question 2(A): Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

As I mentioned during the meeting, I believe the overall success of the AWI effort will depend heavily on the success of addressing issues on private property. I urge ORD to devote attention to addressing the issues associated with defects on private property. These issues pose unique challenges not only from the perspective of access to the infrastructure but also due to the nature of infrastructure on private property – generally very small diameter, minimal entry points, and historically less inspection of the actual installation.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

EPA ORD is to be commended for the extensive collaboration efforts already undertaken with organizations such as WERF, WRF and the Global Water Research Coalition. There is no question that the more extensive collaboration efforts taken at this stage will result in a more focused AWI effort and will facilitate the implementation of AWI programs. With that in mind, possible additional collaboration efforts might include the following – in no particular order:

Federal agencies
NIST
NASA
SBIR
DOT
NSF
Homeland Security
EPA-Enforcement
National Park Service

Other organizations
DOD
ASTM
Gas/petroleum/nuclear organizations
NASA
IEEE
Japanese research organizations
Stormwater organizations

Other Infrastructure organizations:
NACWA/AMWA/ASCE/APWA
Agriculture
Builders & developers
NGO – advocacy groups, e.g. NRDC

Comments from Mr. Larry Johnson

It is my privilege to assist the Science Advisory Board with the subject consultation. As a water and wastewater utility executive, with responsibility for the operations, maintenance and asset management program, I am directly involved in the day-to-day aspects of extending the life of critical water and wastewater infrastructure. The EPA's Sustainable Water Infrastructure Initiative and the Aging Water Infrastructure (AWI) Research Program are important methods to move the water and wastewater industry forward in the continuing efforts to improve asset management practices across the country.

I am pleased to offer the following observations related to the Consult Charge Questions contained in the memo from Sally Gutierrez, Director of Office of Research and Development National Risk Management Laboratory, dated 6/29/2009. These comments supersede my previous comments.

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

The two major goals are clear and provide good direction for the AWI research program. The AWI research program has important and useful research projects included, but the focus of the research program should be refined to more closely align with the program goals. Some areas of the goals, such as "reduce costs and improve operational efficiency, maintenance…" are not addressed by the research program. The application of Asset Management principles to utility O&M practices should be addressed through case studies of successful Asset Management programs, and application of the training available through the Water Environment Research Foundation (WERF)'s SIMPLE program.

The Advanced Programs and wastewater/reuse portions of the research program need to show how they relate to aging water infrastructure. In some cases, this research will change the desired service levels for the infrastructure, and thus change the decisions regarding whether to replace or rehab a particular asset. Encouragement of business case evaluation, including environmental and social costs, is a good mechanism for evaluating projects in light of "green" technologies.

There are many areas of AWI that need to be addressed as part of this research program in addition to the pipe assessment and rehabilitation focus. These include:

- Use of computerized maintenance management systems to provide planned maintenance, manage O&M costs and record field data.
- Knowledge retention concerning aging water systems with poor documentation and retirement of experienced employees.
- Defining critical assets and asset risk to guide condition assessment and rehabilitation efforts
- Expanding condition assessments to other asset types, such as manholes, valves, pumps and control panels

- Use of real time monitoring and control to improve operations and extend the life of existing infrastructure

The AWI research program should also provide methods to predict reductions in the huge capital outlays currently projected for replacement of water and wastewater infrastructure. Timely and efficient rehabilitation of critical assets before they become unusable is a primary method of extending asset life and reducing the projected capital outlays for asset replacement. Determining Best Management Practices and expected extended life with rehabilitation will allow evaluation of rehabilitation vs. replacement.

A computerized decision model available to all utilities, with different levels of sophistication, would provide utilities with a good tool to implement these decisions. Long term funding of capital outlays for rehabilitation and replacement is a policy issue not directly related to this research program. However, establishing dedicated funding sources locally or nationally is critical for this AWI research program to be effective.

Charge Question 2(A): Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

As stated above, the AWI research program contains many excellent projects that will have a considerable impact on the industry. Condition assessment should address force mains as well as gravity mains. Methods to determine condition of force mains and locate gas pockets without taking them out of service would be particularly helpful.

A national data base of condition assessment information, including types of condition assessment, expected life and failure mechanisms of various pipe materials would be very helpful.

Condition assessments should address effects on water quality and hydraulics of corrosion and deposits, such as tuberculation of ferrous pipe. This causes failures before the pipe fails physically.

Charge Question 2(B): Comment on whether research on system rehabilitation will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

General: The wastewater rehabilitation research questions raise important questions for the industry. They are generally separated into identifying the state of the technology, determining long term performance of rehabilitation methods, improving design methods to provide extended life and providing guidance to assist decisions regarding rehabilitation.

The state of technology is a fast changing target that is not easily captured by a review of papers. Any future technology review should be a quick snap-shot over a twelve month time frame, instead of a long term study. Otherwise, it will be outdated before it is completed. A good method to determine the state of technology is by asking major contractors and vendors that specialize in the technology, and then evaluating the information. While vendors are clearly biased, they are closest to the technology breakthroughs. Utilities can also provide a great deal

of experience with different technologies, which is helpful during evaluations. They have less biased perspectives.

A web based information sharing method is suggested to request input on new rehabilitation technologies from vendors and results of demonstration projects from utilities. This approach would speed up the research. It would also provide a method to disseminate information before the complete report is available. Many demonstration projects have already been done and should be considered.

Sewer grouting is a cost effective rehabilitation method for clay pipe sewers if conducted prior to sewer collapse. Better data on infiltration and long term effectiveness should be developed so that it can be considered along with lining systems. There may be limitations on grouting depending on soil types. We have used it effectively for many years.

Lining of sewers is a mature proven technology. We spend $300k per year to line the worst sewers based on TV inspection. Large sewers (30-42") can be slip lined in service, but it reduces the diameter.

Lining of sewer laterals is a technology that is being evaluated, as well as technologies to recut the sewer lateral connections using robotic methods. These technologies protect the utility infrastructure to the right of way.

Research programs should focus on providing tools to make better rehabilitation decisions. Prescriptive guidance concerning rehabilitation methods is not likely to be helpful, because of the variability in sewer system conditions. A computer based rehabilitation decision model, that can be tailored to be more or less complex, would be very beneficial. The decision model should incorporate evaluation of alternative rehabilitation methods vs. do nothing and replace options, using a business case methods to determine the lowest life cycle cost, including risk costs, social and environmental costs.

Rehabilitation of other collection system assets besides piping should be given higher priority. Manholes, clean-outs and pump stations require rehabilitation to reduce inflow from the surface and prevent sanitary sewage overflows (SSO). This can account for a high percentage of wet weather discharges. Manhole protectors and manhole coatings are particularly effective.

Evaluation of rehabilitation vs. replacement options should address methods and costs of road restoration, which may exceed the costs for utility infrastructure. Close coordination with road resurfacing programs can reduce the cost. Neighborhood Improvement projects incorporating rehabilitation of water, wastewater and road infrastructure offer a cost effective approach to this problem. Research to increase the distance between access holes for pipe rehabilitation projects will greatly reduce restoration costs.

The AWI research program should address methods to predict reductions in the huge capital outlays currently projected for replacement of water and wastewater infrastructure. Timely and efficient rehabilitation of critical assets before they become unusable is a primary method of extending asset life and reducing the projected capital outlays for asset replacement.

Determining Best Management Practices and expected extended life with rehabilitation will allow evaluation of rehabilitation vs. replacement. A computerized decision model available to all utilities, with different levels of sophistication, will provide utilities with a good tool to implement these decisions.

Long term funding of capital outlays for rehabilitation and replacement is a policy issue not directly related to this research program. However, establishing dedicated funding sources locally or nationally is critical for this AWI research program to be effective. One approach is to require utilities to dedicate some portion of depreciation expenses to dedicated rehabilitation and replacement funds.

The technology demonstration project is a valuable method to obtain real life experience with various technologies. A number of these technologies have been in use for many years, and the utilities can provide real life information.

The Inspection and quality assurance procedures project is to collect field experience from the utility and vendors in the industry. This is a good effort. It should be expanded to collect specifications and lessons learned from past and current projects to assemble a best practices manual.

The new pipe materials research should take advantage of utility experience with new materials. PVC and HDPE have standards and many years of experience. Fused PVC pipe and mechanically restrained PVC pipe are just being introduced, and need to be tested.

The Design manual on odor and corrosion control should evaluate chemical methods to control H_2S in sewer pipes. Improvements in oil and grease control would also be beneficial.

Rehabilitation of water distribution piping generally follows the same approach as wastewater piping, including the state of technology and demonstration projects. Rehabilitation of water distribution mains must consider water quality and hydraulic considerations as much as pipe integrity. Tuberculation of iron pipes is a major cause of water distribution failure for both hydraulic and water quality reasons. Research methods to clean and line piping with tuberculation would be very beneficial, if it can be done with minimal access points. Methods to coat or recoat ferrous mains without blocking services would be very beneficial.

The cost of providing temporary piping while water or sewer pipe rehabilitation is performed must be considered. Bypass pumping, temporary piping, and line stops with bypasses may be required for sewer rehabilitation. Special disinfection methods and wet taps may be needed to reduce the disruptions caused by boil water notices during water pipe rehabilitation. Restoring service connections and replacing service lines should be studied to determine best practices.

Pipe bursting technology appears to be one method to replace small water distribution piping. This technology should be evaluated and limitations identified. One problem is the need to connect services and dig up fittings.

The decision model and technology demonstration projects for water distribution rehabilitation appear to be very beneficial. The evaluation of innovative repair/rehabilitation methods project needs to clarify the scope and goals of the project.

Charge Question 2(c): Comment on whether research on advanced concepts and innovative treatment technologies will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

Reuse water treatment should be tailored to the use of the reuse water. Requiring very high treatment levels increases cost, and requires higher energy use and carbon footprint. We provide 50-100% reuse from regional facilities using advance filtration and disinfection.

Charge Question 2(d): Comment on whether the cross-cutting, integrative research on water infrastructure will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals.

Research on tuberculation in ferrous piping and methods to prevent it would be beneficial. We also need to know whether exterior corrosion is a big impact, and whether cathodic protection works for push-on pipe.

Charge Question 3: Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

The sequential research approach includes national and regional assessments, state of the technology reports and field demonstrations of innovations.

The national and regional assessment should identify the benefits that can be projected through implementation of asset management principles now, in terms of improved performance (service levels), reduced risk of failure and reduced costs of asset replacement. This assessment should use case studies of advanced utilities that have implemented asset management to identify typical benefits available from asset management implementation. One of the prime questions to be answered is: *How much can we reduce the water and wastewater infrastructure spending gap estimated to be billions of dollars per year, by extending the life of existing assets through condition monitoring and rehabilitation?* Unless we can substantially reduce the funding gap through comprehensive asset management, we face a combination of increased customer costs and reduced service levels.

The national and regional assessment of the impacts of global warming and TWM should be identified by region to guide decision making regarding infrastructure replacement vs. rehabilitation. Changes in service level associated with global warming or TWM need to be identified to determine if policy makers will accept these service level changes. We need to recognize that reclaim water quantities are not sufficient to supply all areas receiving potable water with irrigation needs, unless local water sources or stormwater sources are used to

supplement irrigation. Reclaim water can be distributed to large users (golf courses, parks and open spaces) much more efficiently than to residential customers.

The TWM assessment should consider the need to flush water for WQ purposes in existing large distribution systems. It doesn't help to conserve water at the residence and then flush it at the main. Flushing is a function of treatment type, disinfection chemicals and water age. As systems consolidate, water age gets longer.

Using reclaim water for fire protection is a good idea where reclaim water mains are sufficient size. However, rates for fire protection and reclaim water would have to be adjusted accordingly. A local TWM concept that can be used is the collection of roof rainwater in cisterns for irrigation or gray water applications.

The national assessments are not directly tied to the State of Technology reports and project demonstrations. The State of Technology reports are nearing completion. Therefore, EPA should proceed with the demonstration projects in parallel with the national assessments. Utilities have ongoing needs to replace and rehabilitate portions of their infrastructure on an annual basis. Decisions are being made currently based on available information. The capital costs of these projects are major investments. It is important to provide best management practices to the utility industry soon.

Rather than moving directly to full-scale demonstration projects, case studies of existing technology demonstrations, and pilot tests of new technologies should be used to screen potential technologies. Case studies and pilot tests offer the chance to screen a number of potential technologies before committing scarce funds to a demonstration project. Palm Beach County has considerable experience with pilot scale plants. Examples of pilot scale tests performed in the last three years include membrane bioreactors (MBRs), Integrated Fixed Film in Activated Sludge Systems (IFAS) and reuse filtration technologies. Other utilities have performed similar tests that can be used to screen new technologies quickly. The controlled test facilities being developed by the EPA offer another important method to screen new technologies before a demonstration test is conducted.

Field demonstrations are an excellent method of demonstrating new technologies and transferring those technologies to the industry. As utility executives, we rarely adopt a technology that does not have operating experience in the US. It is important that the demonstration projects use the best technologies available, so that the results provide the most benefits to the nation.

An additional approach that would be helpful is to identify the gaps in available technology, and then initiate focused research to address these gaps. While this approach may take longer, it offers the chance to guide research, instead of following new developments. The example of remote monitoring within distribution and collection systems is one example of this approach. We are currently working to monitor chlorine and pH teal-time within the water distribution system. Another gap is the use of remote sensors within the pipe to perform condition assessments. Force mains cannot be shut down for inspections. Technology to launch and

recover probes in force mains that would evaluate pipe condition and location of H2S gas pockets would be very helpful.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

The research partners for the AWI research program are excellent. The Water Research Foundation (formerly AWWArf) and WERF are both excellent organizations that are closely aligned with the water and wastewater industry. The foreign partners also provide excellent perspective on advancements in their areas. While these international advancements offer possible improvements, they need to be evaluated for their effectiveness within the US water and wastewater industry. I would suggest more information sharing among the research organizations and the utility industry as a whole, to take advantage of work that is ongoing and to pass along advancements as quickly as practical.

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

The Communications Plan is extensive, and provides multiple methods for providing information to external groups. It includes Water organizations, but should be expanded to include water/wastewater utilities, state governments and local governments that are responsible for a large portion of the water and wastewater industry. The internet web site is a good vehicle for providing a broad range of information. It should be arranged to begin with broad concepts and provide progressively more detailed technical information, depending on the audience.

I suggest an expansion of the communication plan to provide input from external sources and feedback on the research program. A web based communication tool available to larger utilities would allow the AWI research group to request information on specific technologies that may have already been tested. The utilities could provide quick information concerning technologies used, pilot scale tests performed and evaluations conducted. The information will enable the AWI research group to streamline technology assessments, and to evaluate alternative technologies based on existing information. This communication vehicle could be through the Water Research Foundation and WERF. Providing utilities an opportunity to provide input to the research program will dramatically increase the awareness and buy-in for the research results.

Comments from Dr. Cindy M. Lee

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

The AWI team did a good job of crafting the goals because they provide focus but flexibility. I have been continually impressed with how the ORD has managed its limited resources to accomplish important efforts. However, the current state of the water infrastructure in the US is a reflection of the past several years funding of the EPA. Too few resources have been devoted to this critical issue.

Given the large investment that this infrastructure represents, is it best to try to move to the most innovative, futurist solutions to avoid being really far behind in technology? Therefore, the goals should be ambitious for the AWI program.

One area for improvement is to have a vision articulated for where the nation should be in 2025, for example, in terms of its water infrastructure. Perhaps a clearly articulated vision for the nation should be an outcome of the five year program. For example, the concept of total water management is where the nation should be directed as we strive for sustainability.

The program team has made good efforts to integrate components across the program, within EPA, and with stakeholders and partners. Perhaps a point person should be named who will ensure that efforts at integration continue throughout the lifetime of the program.

An important aspect of the program is multi-objective optimization. For example, how should the objectives for fire protection and drinking water be reconciled? An important feature of the research should be considering the trade-offs and anticipating unintended consequences.

Are climate change issues adequately addressed by the research plan? For example, in the advanced concepts for WW collection, the concept of increased or decreased rainfall is not addressed. There is little explicit mention of climate change in the advanced concepts for drinking water distribution (research project 5 pp. 67-68).

Charge Question 2

Sustainable should be clearly defined in the sustainable water infrastructure program and relayed in the AWI program.

Rehabilitation of Water Distribution Systems: There appears to be some overlap with force main rehabilitation here. Longevity of the pressure pipe rehabilitation methods need to be evaluated.

Charge Question 3: Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

The plan for a three phase approach to the research is solid. I support the statements by the committee that demonstration projects should be selected with care to ensure significant impacts are achieved.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

There has been little research funding available from federal agencies, industry, or private foundations for water and wastewater infrastructure and conveyance systems over the past 15 to 20 years. As a result faculty in civil and environmental engineering have not devoted time to developing innovative technology. Several faculty who did research distribution systems have retired and have not been replaced with junior faculty with research in the same area because they would not have been able to get tenure because of the lack of funding sources. A review of the directory of the Association of Environmental Engineering and Science Professors (AEESP) shows there are few listings for faculty who listed relevant areas of research for infrastructure. I checked the following categories: A sustained program for research in the area of water infrastructure will provide a reservoir of expertise in academia.

I suggest that the AWI team look for additional collaborators who will bring geographic diversity to help answer questions about effects of climate, coastal issues, and socioeconomic factors. Another group of potential partners might be found in the other underground utilities such as electrical, telecommunications, and natural gas utilities. The US Green Building Council would be a good partner (I spoke with Jill Neal about her efforts to engage the USGBC in a current project). The efforts by the AWI team to work with the on-going projects on water infrastructure by the Australian Research Council are likely to provide good opportunities for partnerships. The current efforts to work with the Chinese to demonstrate technologies in newly developing urban areas (Richard Field spoke of these efforts) are to be applauded.

Some academic disciplines that might provide insight for the problems of AWI include computer vision, computer science and engineering, sensors, and geotechnical engineering. One person who may provide advice is Dr. Tom Henderson, Computer Science Department, University of Utah, who specializes in computer vision and robotics. Arthur Sanderson, Electrical, Computer, and Systems Engineering, RPI, received funding from the NSF for using a sensor network to monitor the Hudson River system. The WATERS Network a NSF project has experience with cyber-infrastructure and sensors for aquatic systems. The Emerging Frontiers in Research and Innovation (EFRI) at NSF awarded a FY08 grant to Robert Bea in Civil and Environmental Engineering and other colleagues at UC Berkeley titled "Assessing and managing cascading failure vulnerabilities of complex interdependent, interactive, adaptive human-based infrastructure systems. " The group is studying the interacting aging infrastructure that provides flood protection, water distribution, and electrical power in the Sacramento–San Joaquin Delta area to investigate the probability and consequences of failure of the systems. The plan is to

consider how to design for resiliency and sustainability. Other EFRI awards to Arizona State University and University of Arizona researchers include water infrastructure in their studies. These research projects might provide some leverage for the AWI program. I also suggest contacting James H. Garrett, Civil and Environmental Engineering, Carnegie Mellon University, Center for Sensed Critical Infrastructure Research.

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

The communication plan is strong and thorough. It gave me confidence that dissemination would be successful.

Comments from Dr. Reid Lifset

Thank you for the opportunity to participate in the Consultation on Aging Water Infrastructure (AWI). Addressing the aging infrastructure is a very important task and I'm pleased to contribute to the review of this effort.

I found both the research plan and presentation by the Office of Research and Development to be coherent, thoughtful and appropriately detailed. The comments that follow focus on the research program as a whole and on those charge questions with I was assigned.

Generating useful and appropriate research on a topic that is so broad and complicated is of course a challenge. The Agency has chosen to limit the focus of the research to the science and engineering aspects of aging water infrastructure. In my view, a greater role for the social sciences is needed in research on AWI as many of the key issues are not centrally technical matters. In the case of water infrastructure, the need to systematically attend to the social, economic and political dimensions is made more complicated by the time frames involved. Because infrastructure is long-lived, involving large capital investments, there are obvious challenges to flexibility. As is noted in the research plan and the SAB EEC discussions, there is often a mismatch between the time frames dictated by physical nature of water infrastructure and at least two desired goals. First, water infrastructure is often used beyond its intended design life, prompting the need for repair, rehabilitation and replacement, sometimes on an ad hoc basis. Second, the use of new technologies can be delayed because water systems cannot afford to abandon existing capital investments. These challenges are both technical and social in character.

An implication for the research plan is that the technical aspects of work—on condition assessment, rehabilitation technologies, etc.—need to incorporate considerations of resiliency directly into the analyses. Currently, resiliency along with other considerations related to sustainability (e.g., energy use, impact of climate change) are relegated/isolated in specific portions of the program work plan, primarily in the climate change document, and the multi-scale analysis. I urge the Office of Research and Development to include consideration of resiliency throughout the research program, so that considerations of unanticipated or abrupt change whether from climate change or financial market meltdown and global recession have a greater possibility of being managed effectively. To take one tangible, albeit modest, example, rehabilitation technologies are important for their own sake as a cost-saving means of maintaining the functioning of water infrastructure, but they are also important because they allow nimble responses to systems needs that can be used in the face of unanticipated change. Thus, the technical research on rehabilitation should consider how the use of a particular rehabilitation technology constrains future decisions. Can the same technology be used twice in the same place? Does a given technology preclude the use of other technologies in the future?

Charge Question 3: Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

Regarding charge question #3 on the sequencing of the components of the research program, I find the strategy to be well-conceived and coherent. Sequencing the program components rather than running them in parallel allows for learning and adaption. It also sidesteps some of the more complicated coordination tasks that simultaneity entails. With regard to the use of full scale demonstration projects, there is an obvious level of credibility that such demonstration projects will engender with many of the program's constituencies. However, I think an even more important consideration than the efficacy or cost-effectiveness of full-scale demonstration is that the demonstrations are only as good as credibility of the demonstrated project itself and the effectiveness of the dissemination of the results. Is the right sort of system chosen for the demonstration? Are the key data collected and made available to those who need to be convinced by the demonstration?

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

Regarding charge question #5 on the communication plan, I am very impressed by the level of detail in plan, e.g., the careful delineation of responsibilities for the various aspects of the plan shows hard work and good management. The elements of communication plan are spelled out effectively in many respects, but I suggest the addition of an additional dimension. Distinguish between 3 tasks:

1) Getting attention—making sure the various constituencies know that the AWI project exists.
2) Making the information generated in the project accessible—ensuring that someone looking for information related to the topics making up the AWI can find it.
3) Gaining adoption and feedback –succeeding in having users respond to and adopt the results of the AWI.

Workshops, webinars, and podcasts are most conducive to the 3rd task, but not so effective in the first. Publication in peer-reviewed journals is effective in the 2nd task because of the extensive indexing and abstracting of the formal literature.

Thank you for this opportunity to participate in this consultation. I would be happy to respond to questions or otherwise clarify my feedback.

Comments from Ms. Liliana Maldonado

This letter is sent as a follow up to my participation in the Consultation on the Aging Water Infrastructure Research Program, held on July 21 and 22, 2009, in Cincinnati, Ohio, for the purposes of providing written comments in addition to the oral input provided during the meeting. Charge questions specifically assigned to me are noted with an asterisk, but comments are also provided for other charge questions as appropriate.

General Comments:

The Aging Water Infrastructure Research Program is a much needed and important contribution to the development and understanding of innovative technologies and techniques for reducing the cost and improving the effectiveness of operations, maintenance, and replacement of aging and failing systems for drinking water and wastewater treatment, distribution and conveyance. As a 30-year practitioner in this industry, I am keenly aware of the needs, and EPA's efforts through the development, funding and implementation of this program are sure to expand the body of knowledge necessary for the continuing enhancement and protection of our Nation's infrastructure. Before my appointment to this consultation, I was not aware of this program. Perhaps this is the most important point I'd like to make: EPA cannot underemphasize the value and need for communicating broadly and effectively with internal and external stakeholders regarding the scope of this program and its potentially far-reaching implications. Staff has clearly understood this issue, as reflected by the inclusion of a comprehensive and robust communications plan within the research plan. I encourage EPA to provide its full support and assistance to Program staff to ensure that the communications plan is fully executed and continually evaluated for effectiveness and needed improvements. This will ensure that the investment in this program and the research sponsored within it are fully leveraged.

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.*

Yes, the program is addressing some important and significant issues facing our country's aging infrastructure. However, to create maximum leverage for the research and demonstration projects being conducted, the following potential enhancements should be considered:

1.1. Provide for greater coordination and integration of this effort with other EPA efforts (e.g. Office of Water and Office of Compliance upcoming areas of focus and/or initiatives) in order to anticipate future drivers of greatest impact to potential end-users for the technology (i.e. the regulated community) and ensure that the projects within this program are prioritized and funded accordingly.

1.2. Work proactively to leverage this program via a focused partnership approach with the AWWARF and WERF Cooperative Agreement to ensure that technologies within the projects funded by this program are not only 'demonstrated in the field' but also that an effort is made to find feasible sites for implementation of such technologies within a reasonable

timeframe. This will facilitate actual full-scale application of viable new technologies in relevant geographies, translating the benefits of the research into measurable and specific outcomes that will truly advance goals of this program.

2. Charge Question 2*

In general, the research focus areas identified are appropriate and will provide tangible documentation of new technologies offering the potential for reduced infrastructure upgrade costs and/or increased effectiveness. One of the key challenges faced by utility agencies is lack of funding; in this regard, this program should also address the 'how-to' associated with implementing any promising new technologies. Specifically:

2.1. Some of the questions often asked include: what are the risks associated with use of such technologies and how do we manage or mitigate these risks?; how can we make an informed decision on costs vs. benefit vs. performance vs. risk for any new technology that we may choose to use?; how will future regulatory drivers and/or changes in water and wastewater quantity and quality impact the long-term applicability and effectiveness of such technologies? In this regard, to provide greater opportunity for achievement of program goals, the projects funded by this program should also explore the implementation challenges and opportunities associated with any new technologies that are demonstrated, focus on the decision making and risk-management processes, and identify the key enablers that will facilitate the adoption of such technologies in full-scale constructed projects. It is unclear to what extent this will be an element of project- and/or program level final recommendations or reports yet this will be an important element to achieve overall program success.

2.2. Development of design manuals, for example, is a great way to translate fundamental- or applied- research into practice. Several such products were identified in the original research plan published and approved in 2007 but do not appear to be in the currently-funded scope of activities (e.g. odor/corrosion control design manual, which would be a very valuable product the engineering designers and utility managers responsible for rehabilitation and repair of affected wastewater collection systems). Funding of these types of activities or projects should be facilitated and encouraged as the research agenda continues to evolve because they provide a critical and valuable 'tool' for use by water infrastructure practitioners that would translate this research into measurable results.

Within the 'advanced concepts' research focus area, the research program appears to be primarily focused on the evaluation of 'green infrastructure' technologies for stormwater management—this is a departure from the original research plan presented in the 2007 report, which was broader and more comprehensive in its scope. While this is an important area of practice, it is not necessarily relevant in all parts of the country nor feasible in highly-urbanized geographies where the challenges of aging combined sewer systems, pressures for increased capacity needs as driven by population growth, and limited green space availability significantly reduce the viability of these technologies for the large-scale applications which are typically necessary in such situations. A more balanced portfolio of projects that includes other advanced concepts as originally envisioned in the 2007 research plan should be considered as the program continues to evolve.

The 'innovative treatment technologies' focus area of the research program could also benefit from increased focus in the areas of water reclamation and reuse (which is of particular importance in water-short areas of the U.S. such as the Southwest and Florida), integrated wastewater management solutions and emerging contaminants source controls and/or removal. These are increasingly important areas of concern to the regulated community. The current research program has limited focus in these areas, which are estimated to drive significantly the costs of new and/or upgraded water infrastructure systems in the years to come as contaminant detection technologies advance at a much more rapid pace than source-control and cost-effective treatment technologies, and as the general public continues to demand risk-free unlimited water.

Finally, there is a need to develop a comprehensive 'road map' that illustrates the relationship between the four research-thrust-areas and the individual projects within these areas, with the findings from the national- and regional- assessments of technology. While individual projects appear to have some inherent value and potential benefits, it is not clear how these projects were selected and how together, they help to fill the prioritized needs and gaps outlined in the 2007 research plan or other stakeholder priorities. This road map is an important tool to facilitate the stakeholder communications and technology transfer goals outlined for the program while ensuring that any projects funded in the future complement the current projects within this program and/or within other programs funded by or in collaboration with the identified partners.

Charge Question 3: Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

Yes, this is a good and solid approach that will provide necessary documentation of the state-of-the-art for select technologies and facilitate a linkage between fundamental and applied research, both which are key to the practical application of any new technologies. However, this program must not stop here.

3.1. It should also serve as a catalyst for enabling collaboration with other EPA offices to facilitate implementation of more flexible regulatory and funding mechanisms at the grass roots level. There is a great need for increased training of state- and local- permitting agencies and regulators, who often times lack the expertise and/or experience to facilitate the application of new technologies for design and construction infrastructure projects, resulting in less than optimal solutions driven by ultra-conservative regulatory and permitting approaches that focus primarily on end-of-pipe solutions rather than the full spectrum of integrated water and wastewater management solutions. Even if new technologies are 'demonstrated' as viable via this program, permitting and funding mechanisms must also be in place to ensure that the end user is encouraged to embrace the application of these technologies and that regulators and permit writers are equipped with appropriate tools to facilitate and encourage their full-scale implementation.

3.2. The recently-signed Cooperative Agreement with AWWARF and WERF, could be used to pair up the interests and priorities of their member agencies with the findings of the national- and regional- assessments performed in this program, to identify new projects that could be funded, or jointly through the Agreement, leap-frog the understanding and full-scale implementation of key technologies showing greatest opportunity and promise for infrastructure system operators and owners.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

Yes, the ORD has assembled and impressive list of partners and stakeholders for this effort; the key challenge still remaining is to align these partners and stakeholders with the issues of greatest relevance from a geographic and/or triple-bottom-line perspective (economic, people/society, environment) so as to maximize the potential benefits arising from the research being funded by this program and leverage the work being done with and by others. To maximize the reach of this research program within appropriate interest groups and industry professionals as represented by the potential partner organizations that have been identified, prioritization and definition of specific and tangible goals for each partnership should be considered before moving forward with any outreach efforts.

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

In general, the answer to this question is yes. However, if anything, the communications plan and associated strategies are very ambitious and broad, and must go beyond information- and technology- transfer into a deliberate dialogue with end-users that translates into actionable solutions that actually demonstrate improved effectiveness or performance of existing systems and technologies and/or reduce the costs for rehabilitation and repair of aging infrastructure. A general concern worth noting is that the resources allocated to the communications elements of this program may not be sufficient and/or that the information transfer may not be targeted enough or balanced enough among internal and external components. As individual projects are identified, funded, and completed through all three stages of project development, it will be important to evaluate and select the most meaningful strategies and tactics for each particular research topic/project, partner(s), and potential end users.

It has been a privilege to work on this consultation, dialogue on the issues and share some individual perspectives with you and the members of the Science Advisory Board Environmental Engineering Committee.

Comments from Dr. James R. Mihelcic

Charge Question 2(A): Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

No comments

Charge Question 2(B): Comment on whether research on system rehabilitation will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

System rehabilitation is defined as the application of infrastructure repair, renewal and replacement technologies in an effort to return functionality to a drinking water or wastewater system or subsystem. The decision-making process for determining the proper balance of repair, renewal and replacement is a function of the condition assessment, the life-cycle cost of the various rehabilitation options, and the related risk reductions.

The proposed research is strong in something your laboratory does very well, that is, resulting in outcomes that provide technical expertise that can be integrated with engineering education and practice.

There will be tangible outputs and outcomes that will support Aging Infrastructure Research Program goals, but in my opinion, much of the research plan has a short-term outlook. This is because system rehabilitation performance is being evaluated on 20th century measures of performance; function, risk reduction, and economics.

As I stated, this is a 20^{th} century view of engineering design and management and not one that meets a "sustainable water infrastructure initiative." It is my opinion the research program will allow EPA to move the "state of the technology" forward, in a small incremental improvements, responding to immediate concerns of cities and municipalities.

For a research program that embraces a "21^{st} century Research Plan", performance must be expanded beyond function, cost, safety, and risk, to include local and global considerations of environment, human health, and social wellbeing. Geographical location will become increasingly important, in regards to distinct site conditions, water and energy availability, level of urbanization and population growth, and very important to the discussion, cultural considerations of households, community, and governance.

The design process must also evolve to include issues critical to a sustainable solution such as resiliency, life cycle, the surrounding system, and intended lifetime. It is especially important to evaluate environmental assessment over the life cycle, therefore, life cycle assessment should thus be included as a performance criteria. This is especially true for rehabilitation where EPA to is researching materials for piping, linings, and grouting. It appears there are some individual "separate" projects that include some of these new measures of performance in the advanced water/energy design for sustainable infrastructure. The analogy is the solution of new roads to

- ***Resilience*** is the capacity of a system to survive, adapt, and grow in the face of unforeseen changes, even catastrophic incidents (Fiskel). Given the uncertainty and vulnerability around sustainability challenges such as climate change, population, our economy, water scarcity, and energy demands, it is likely sustainable designs will need to incorporate resiliency as a fundamental concept.

This is an important because in Dr. Speth's talk he stated that one goal of EPA's rehabilitation programs is to "Extend the service life and functionality of existing conveyance systems and reducing their life cycle cost".

- ***Life cycle*** considerations account for environmental performance of a design through all phases of implementation; from raw materials acquisition, to refining those materials, manufacturing, use, and end-of-life management. The entire life cycle needs to be considered because different environmental impacts can occur during different stages.

I will provide just a few specific examples. In terms of wastewater collection system rehabilitation, the proposed research questions (page 32 of Attachment 3) are focused solely on incremental improvements we may see over the next decade. For example, beyond function and cost, what are the environmental stressors associated with use of particular materials in rehabilitating or replacing collection systems, and what are the local, regional, and global implications of using a particular technology. Recovery of water, nutrients, and energy should be the driving forces of sustainable research for the 21st century.

An example of the importance of geographical distinctions being important, especially as EPA enters into the field demonstration part of the research, and also for future considerations in this century, issues of water scarcity are already important in parts of the country and will become more prevalent in other areas as this century progress. The three demonstration sites mentioned in Dr. Selvakumar's talk on lining technologies all seemed geographically similar to me: Columbus, Indianapolis, and Omaha.

I understand the study is focused on evaluating lining materials. However, it seems they should have some geographical diversity associated with them. For example, coastal counties in the U.S. are experiencing greater growth and have a much higher population density than inland counties, and many of them are located on very fragile marine ecosystems where infrastructure must be designed to adapt to climate change for example. Important to that study, in communities where water conservation and associated water reclamation strategies will have to get more aggressive and innovative in the future, this will change the strength of wastewater found in collection and treatment systems and ultimate the management strategies and technological innovation to address them.

Related to the "Biofilm Test Loop Research Project," some impacts of water conservation and green building design on water quality could be easily incorporated into the experimental design that researches the physical, chemical, and biological phenomena that occurs in drinking water distribution systems. I think this should also include phenomena that occur at the house after the water leaves the distribution system, or perhaps in water supply systems that are being I combined and now have longer distribution time periods, or perhaps what happens with

reclaimed water. I just suggest that the experiments deal with current concerns, but also look forward to address issues that are on the horizon.

Charge Question 2(c): Comment on whether research on advanced concepts and innovative treatment technologies will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

I would like to note that innovation can be either technology or strategies and configurations. This is especially important in the area of water reuse and reclamation. The research is focused on technology innovation. I see no reason why there could not be research on strategies and configurations. In either case, I would suggest that the innovations be defined better so it is clear whether strategies and configurations are included or not.

For the research on LID, in regards to test beds, it seems that the test beds all have a similar geographical location in regards to climate. I think that EPA needs to think carefully about why these field demonstrations are applicable to the rest of the country, especially in regards to operation and maintenance. For example, how does dry and wet weather extremes of southwest and southeast impact the performance versus freeze thaw conditions of the north. How about plant selection which is critical to performance. Lastly, I would think it is appropriate to have field sites for LID that are located in economically diverse parts of the country. It is important that we be able to study how people and communities interact with this technology, especially because for it to have an impact in restoring urban watersheds, the technology will have to be implemented beyond educational facilities and big box stores. FYI, there is some work in Tampa in the economically disadvantaged community of East Tampa (funded by EPA P3 Phase I and Phase II Awards) that is looking how these communities interact with stormwater retention and detention ponds. EPA might also want to advertise these field sites with the academic community and winners of EPA Star Fellowships who might be looking for field sites to work on the social-technology interaction.

Charge Question 2(d): Comment on whether the cross-cutting, integrative research on water infrastructure will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals.

In order that tangible outputs and outcomes be obtained from the cross cutting, integrative research, I would like to see a definition for what cross cutting means clearly spelled out. This would better help reviewers of the program evaluate whether outcomes are met. Now to me it sounds more like interdisciplinary research or the place you place other research that does not fit into one particular category.

Dr. Speth spoke about how some work your group is doing is related to or can build upon research on stormwater management coming out of the "sustainable technologies" program. This to me sounds more like cross cutting research.

Systems thinking is one issue that needs to be worked into the design process and EPA's measures of performance. ***Systems-thinking*** considers component parts of a system as having added characteristics or features when functioning within a system rather than when isolated.

Given that sustainability challenges are complex, depend on interactions and interdependence, particularly in relation to human behavior and globalization, and are currently managed or mitigated through disparate mechanisms, there are clear advantages to integrating a systems context into the research program phase.

As one example, how is wastewater collection integrated with technology and strategies of water reclamation? Added on to this are issues of how do we aggressively recover water, nutrients, and energy and what is the environmental burden (over the life cycle) of use of water, materials, and energy to implement a particular technology. Here innovation would include not just new technology but also new configurations and strategies (strategies being included in what EPA refers to as advanced concepts).

I think EPA needs to think more broadly, how will the infrastructure of water and wastewater integrate with the infrastructure of mobility (i.e, transportation) and buildings? How will existing and proposed infrastructure integrate with many community transportation planning programs to make the urban corridor more densely populated? Will society's movement towards green building design and successes in implementing water conservation impact the research impact sulfur chemistry (in corrosion) from higher strength wastewater? How are strategies and configurations used versus adding innovative technology. These appear more cross cutting and integrative research topics.

Charge Questions 1, 3 and 4

ORD may want to consider adding the Association of Environmental Engineering & Science Professors (AEESP) as a research partner (or at least working with them informally). Many close by university partners may be looking to work with data you obtain from your field sites, or also performing research where you just provide access to the site.

You can diffuse technology for LID, water reuse, and nutrient recover from wastewater (i.e, composting latrines) through Interior Department, through our National Parks, especially through their ability to obtain building funds for LID demonstration. They can also integrate construction with education and research groups on a regional basis and with nearby university and community college partners.

I would like to clarify this comment that I think geography is not necessarily a barrier to performing cutting edge research. I council students interested in issues of water reuse and reclamation to investigate employment in particular states where issues and engineering practice are focused on these issues. However, I think ORD's location and existing research partners (especially through their field demonstration sites) potentially hampers them on issues of water reuse and reclamation. This is because most of the leading research and practice on this issue comes from people working in just a few states. I would suggest ORD think of a plan on how they can better integrate with this community. I think their partnership with WERF is an excellent opportunity for the ORD staff to get embedded with this community.

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

In regards to transfer of results, I think there would be interest by the membership of AEESP in a communication relationship that would use AEESP as a forum to disseminate information, either through their newsletter or email list. You could also work with the Association of Environmental Engineering and Science Professors (AEESP) to organize workshops at an upcoming Education and Research Conference (2011, 2013 etc.). These workshops could also be tailored for WEF membership at their annual conference. They may also want to submit an article to American Academy of Environmental Engineers (AAEE)'s Environmental Engineer. They have a mechanism to accept peer reviewed case studies, their distribution is small in numbers (several thousand), but the members of AAEE are people who have positions to implement change.

Comments from Dr. Horace Moo-Young

Charge Question 2(A): Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

For the Condition assessment research focus area, the overall research projects and plans are well defined. However, there are areas that can be extremely impactful if implemented. The utilization of nanotechnology and embedded sensors could provide potential solutions. GIS is another existing technology that could provide the AWI with a pathway to assess the current condition.

Failure mechanisms of systems due to corrosion and loss of structural integrity may want to develop a partnership with ASTM, and may look to the structural and materials engineering community to develop new guidance on the long term failure mechanisms.

One overarching question regarding the research plan is What is the realistic assessment of new and innovative technologies "Crossing the Chasm" (See Figure 1) and become common place in water and waste water technology to improve infrastructure? In Civil Works Projects, governmental incentives and policies drive the integration of new technology into the state of practice. Thus, guidance documents and workshops will need to be utilized significantly to persuade municipalities, local utilities, and industry to potentially use the new technologies developed.

Next, the research areas are developed through a national survey and assessment, and demonstration project. I strongly suggest that the project utilize the U.S. Department of Defense (DoD) approach of applying the categories of basic, applied, advanced technology development, demonstration and validation, engineering manufacturing, and management support (See Figure 2). This should be combined with an technological probability of success and the technology competitive position.

Other comments on the document which relate to all four areas of question 2 included the following:

1. No timeline was indicated for the research projects in Condition Assessment, System Rehabilitation, Advanced Concepts or Innovative Technologies..

2. There is no mechanisms for direct technology transfer (i.e., Lack of alignment between policy drivers and ability to implement technology). There needs to be a mechanism to train state and local policy makers.

3. Lack of Linkage to SBIR Program: SBIR program can be significantly leveraged for new and innovative approaches,

4. Lack of clearly defined road mapping strategy which take into account the feasibility of technical success.

5. ROI not clearly defined, and thus there needs to be an incentive to drive the ROI or a policy that drives the ROI

6. No risk evaluated for the potential research conducted. Many of the projects seem to be more short term focused.

7. No linkage to a budget. The budget is extremely small. EPA ORD should be applauded for stretching federal funds to maximize output of quality applied research.

8. Lack of Benchmarking. There needs to be a complete assessment that benchmarks the technologies so that the investments can be coordinated versus potential for saving, sustainability and conservation.

9. Cost Benefit analysis must be conducted on these projects. CBA can drive the ability to implement new technology and influence policy makers to increase funding and incentives to drive the new technology diffusion.

10. Basic Research does not seem to be the driver for the research. For example, NRMRL should develop longer term research that would look at advanced material degradation techniques used in material science to develop and validate models for corrosion and failure assessment.

Editorial Comment: The four areas that were addressed (CA, SR, AC, and ITT), were clearly written by different authors. There is a lack of strategic coherence between the priorities, assessment, and budgetary implications of the plans presented. The research projects outlined in 2007 document are not the same as the project in the Powerpoint presentations.

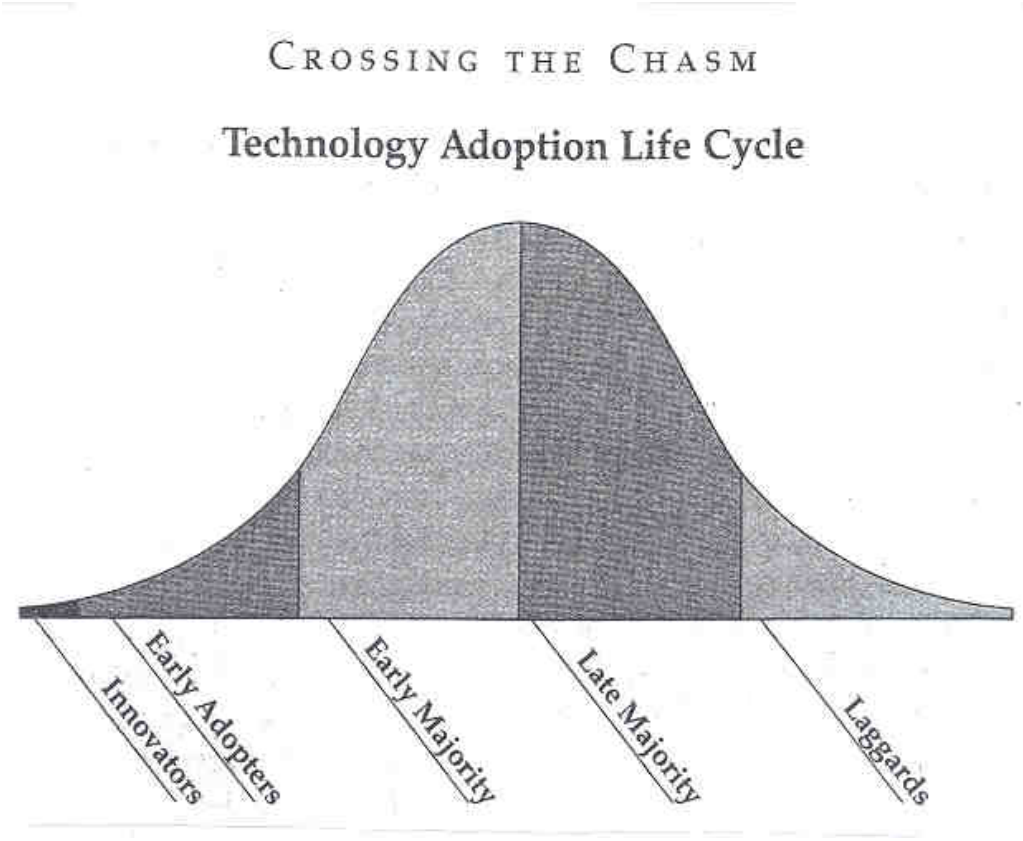

CROSSING THE CHASM
Technology Adoption Life Cycle
Innovators
Early Adopters
Early Majority
Late Majority
Laggards

Figure 1

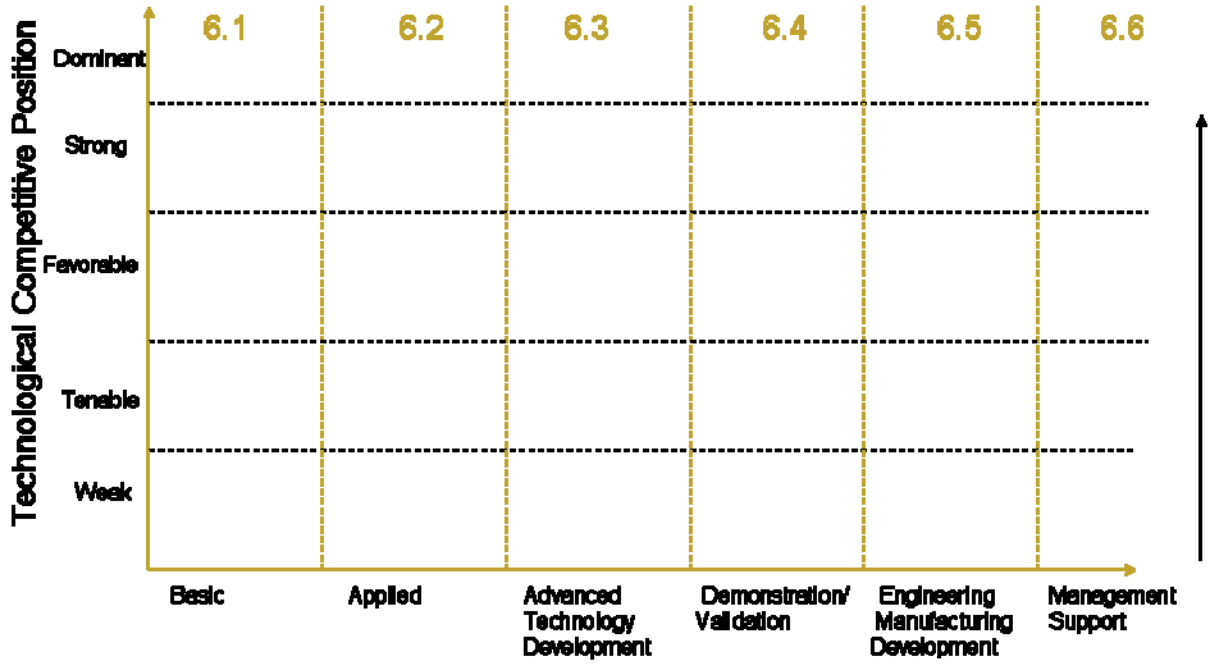

Technological Competitive Position
Dominant
Strong
Favorable
Tenable
Weak
6.1
6.2
6.3
6.4
6.5
6.6
Basic
Applied
Advanced Technology Development
Demonstration/ Validation
Engineering Manufacturing Development
Management Support

Figure 2

<u>Charge Question 4:</u> Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

Additional partners that could be leveraged by EPA include:

1. American Petroleum Institute
2. Electric Power Research Institute
3. National Energy Technology Lab (DOE)
4. Soil Science Society of America
5. American Society Agronomy
6. USDA
7. USGS
8. AGU
9. NOAA
10. National Geologic Survey

<u>Charge Question 5:</u> Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

Stakeholders include the following in Table 1 and stakeholders were involved in key meetings throughout the planning, assessment, research and dissemination:

Membership Organization	Federal	State Agencies	Local Government	Academia	General Citizens
American Water Works Association Research Foundation Global Water Research Coalition (GWRC)	Policy makers Legislators EPA Administrators U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Pipeline Safety (OPS) National Research Council Canada, Institute for Research in Construction (NRC-IRC) – DOE	State EPA or Equivalent Governors	Cities Municipalities Utilities	Penn State University, Pipeline Infrastructure Research Center - University of Houston, Center for Innovative Grouting Materials and Technology - Louisiana Tech University, Trenchless Technology Center - Polytechnic University of New York, Department of Civil Engineering Researchers	General Public Industry technology vendors Consultants researchers, inspection service provider Non-governmental Organizations and Advocacy Groups

The Communication Plan for AWI provides details of the agencies approach to communicating to target audience. The Strategy is very well planned. Communication strategy includes

website, briefing books, brochures, flyer, press releases, blogs, listservers, guidance documents, Talking points and PowerPoints for EPA Admin, AA, Lab Director, etc., Internet/Intranet (Central web page and web-related outreach), Science Briefs, Peer-Reviewed Journal Articles and Trade Journal Articles, WSWRD Internal Newsletter, ORD/NRMRL Newsletters, Community-Level products (events, demonstrations/training), Technical Conferences (presentations, workshops, exhibits).

Guidance documents and workshops are very essential to the training of practicing engineers. There needs to emphasize the training and workshop model used in the 1970-1980's to disseminate information broadly. A blue/purple book approach to train the stakeholders will be critical to effectively communicating and engaging the stakeholder community. Web based dissemination of case studies, videos, and training can be an effective way to reach your stakeholders. In addition, ORD may want to utilize software such as Copernic (http://www.copernic.com/) to manage, and update information in websites and guidance documents. EPA CLU-IN website may also be a prototype for developing the information dissemination for Aging Water Infrastructure.

Online/Distance education, webcasting and podcasting may also present a mechanism that you can reach your stakeholders. Most practitioners attend one day seminars and the example would be the solid waste management and landfill design seminars that took place in the late 1980s and early 1990s. In addition, the academic community should be leveraged significantly through training and educating the educator. One mechanism may be to create a textbook geared towards faculty and students and provide the book and online training. Another opportunity may be to partner with a local university to offer the training through a university extended education program. This can be accomplished through groups such as AEESP, WERF, AWWA, and other academic communities.

External Communication strategy is missing direct tactics to outreach to Small Business, Construction, and A&E Industry (i.e., Industry --utilities, technology vendors, Consultants researchers, and inspection service providers).

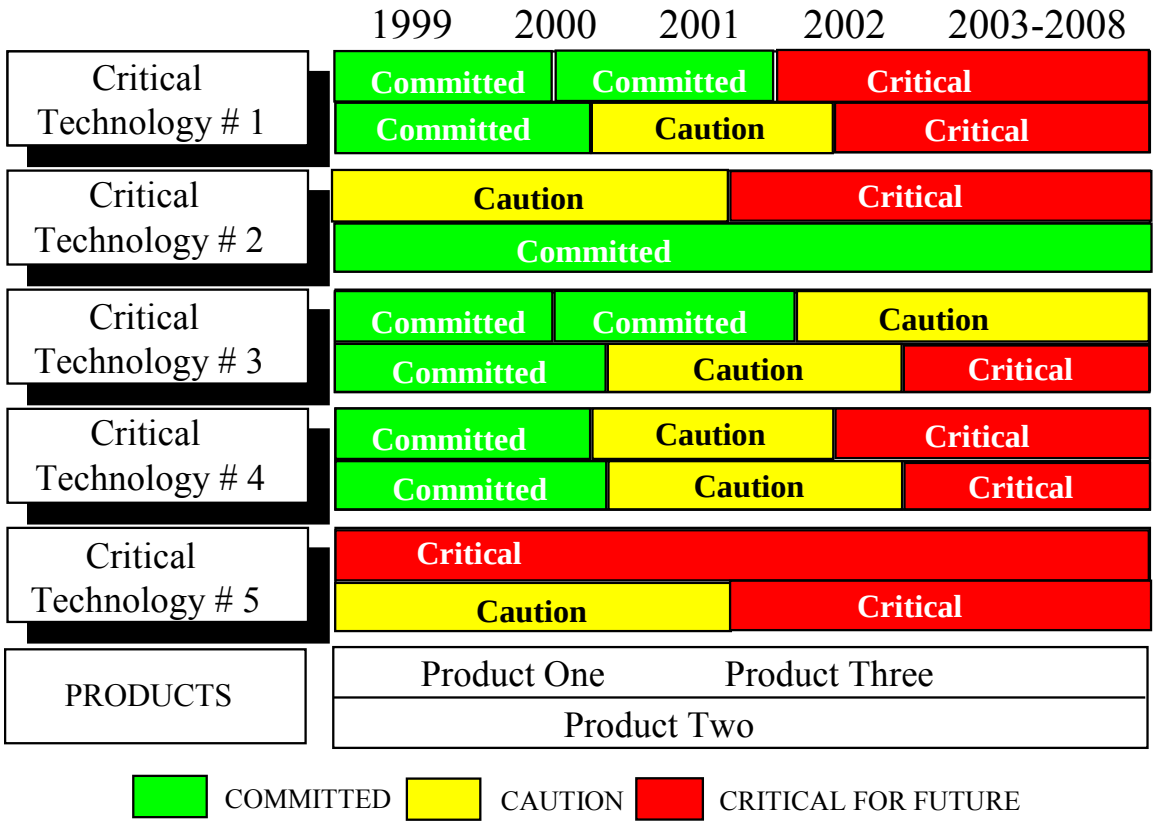
How many people will the communication strategy ultimately reach? There is no guidance in the communication plan which provides a baseline for how a particular tactic will result in a given dissemination to the target audience.

This document is missing a technology Road map that maps the needs for technology. A Roadmap is the view of a group of how to get where they want to go or achieve their desired objective. (*Discipline*)
In addition, a Roadmap helps the group make sure the capabilities to achieve their objective are in place at the time needed. (*Focus*)
Roadmapping

- is a *Learning* process for the group.
- is a *Communication* tool for the group.

Roadmapping must be conducted in the planning phase.
Three references to roadmaps in the document, but nowhere is there an actual roadmap that integrates the needs.

Sample of a Completed Technology Roadmap



Comments from Dr. Catherine A. Peters

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

I am impressed by the breadth of this research program. It has balanced coverage of both the water treatment and the wastewater industries. It is comprehensive with regard to the breakdown areas, which are condition assessment, system rehabilitation, advanced concepts, and innovative treatment technologies. I am particularly impressed with the "advanced concepts" area, which is currently designed to address green technologies related to water. This area gives the ORD the flexibility to explore research topics that are "outside-the-box", and may have a great pay-off but farther in the future.

Finally, this research program is rich with collaborations and partnerships, including international outreach. Also, there is wise use of leveraged funds.

Sustainable water infrastructure is enormously important, and attention is critically important. The fact that the infrastructure funding gap is expected to reach $500 billion in 20 years is very compelling. Clearly this is a problem of enormous proportions, and it requires immediate and focused attention.

In regard to the charge question, will this program make a significant national impact? One way to think about this is to ask, where are we going to be in ten years? And will this program lead to a revolutionary shift in how things are done in the water industry? While I am very enthusiastic about this research program, and these 26 research projects, I am skeptical that there will be a significant national impact. We are trying to fix a system that is inherently inefficient. (Such as the need to purify water to an incredible standard, just to store it for fire protection.) Also the nature of the industry is that it is driven by regulation, not by the traditional economic drivers that would normally create a hunger to be the best and drive innovation. Thus, change and innovation in the water industry only happens in response to crises, and not long-term forward thinking.

This barrier to adoption of innovative technologies means that ORD's job is particularly difficult. They have an enormous task, which is not only to develop and demonstrate new technologies but also to push them into the industry.

Appropriately, ORD has identified this as a time not just to rehabilitate infrastructure, but also to modernize infrastructure. The current crisis of aging water infrastructure presents a unique opportunity. There is an impetus for innovative thinking to apply new methods that are ripe for development and application. Now is the time to be thinking "outside-the-box", to not only fix an existing inefficient system, but also to think about what the water system of the future should look like. ORD is doing that, in part, through the work they are doing under "Advanced Concepts". But in my opinion, it is a small effort and should be increased. That is the only way we might get revolutionary thinking.

Another important effort is that which will lead to adoption of the innovative technologies that ORD is developing. Appropriately, a goal of this research program is: "to develop a generally agreed to, practical, reasonably achievable, definition of 'optimized' water distribution system. This effort will require bringing diverse perspectives into common perspective and desired level of service considerations and cost considerations." Similarly, one of the expected impacts is: "The initiative will increase the adoption of new and innovative infrastructure designs, management procedures and operational approaches …"

The most direct way to instigate change in the water industry is through regulation, since that is the only driver that the industry responds to. The ORD should strengthen its ties to the Office of Water to ensure that policies and regulations are directed at improving the aging water infrastructure.

Furthermore, the ORD should strengthen its plans to disseminate its findings to water utilities. It is good that there is an organized communications program as part of the Aging Water Infrastructure program. However, there should be concrete measures of success with regard to the extent to which innovative technologies are being adopted and the extent to which the $500 billion funding gap of the future is closing. I would like to see these measures of success accompany the other things listed as "Accomplishments to Date", i.e. the traditional products of a research program: reports, proposals, grants, forums and workshops.

I love the mission statement of the communication plan: To change how the nation views, values, manages, and invests in its water infrastructure. This is outstanding. But it is not likely to happen without greater buy-in from all of EPA, and even Congress. Perhaps we need more than a communication plan (because this is about pushing); what we need is a stimulus plan directed specifically at water infrastructure.

Comments from Dr. Mark Rood

General Comments:

Congratulations to EPA for its development and initial implementation of its "Aging Water Infrastructure Research Program." It is a huge and very interdisciplinary initiative that will have long lasting impact.

Synthesis across research projects should consider energy, greenhouse gases, sustainability, and total water management as much as reasonably possible.

Charge Question 2(d): Comment on whether the cross-cutting, integrative research on water infrastructure will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals.

Given these goals, is the program appropriately focused to make a significant national impact on the major technical issues facing our aging water infrastructure? Could the program goals be refined to improve program effectiveness?

Overall yes, however recommendations are provided to enhance long-term and more interdisciplinary outputs/outcomes

Do the program activities and projects appropriately support the current program goals or are additional activities or projects necessary?

The EPA presentation about cross-cutting integrative research was much more focused than the research matrix and funded research projects that are provided in the Program Plan that is dated 2007. The EPA presentation about cross-cutting integrative research pertains to bench-, pilot-, and full-scale projects as described below:

- Water chemistry and corrosion
- Copper and lead solubility/corrosion tests
- Analysis of distributions system and domestic drinking water distributions system materials (interagency agreement USGS/DOE?
- Solids materials analysis capabilities
- Molecular Characterization of Microbial Induced Concrete Corrosion (MICC)

However, funded projects include:

- Broader rehabilitation and condition assessment
- Nutrient control
- Green Roof/Porous asphalt
- Sustainable network design (water distribution and energy)
- Multi-scale infrastructure assessment
- Water reuse
- Wastewater treatment

Select areas that should be strengthened, pending available support:

- Care to determine when to scale-up (cost, timing, acceptability)
- Alternative materials such as self-healing smart materials and experiences with Department of Transportation materials research should be explored
- Materials deposition in distribution systems (note public comment by DuCoste)
- Structural/geotechnical aspects of water distribution and treatment systems (also provided by public comment: Joel DuCoste)
- Broader range and more specific remote sensing techniques of water distribution and water treatment systems (also provided by public comment: Joel DuCoste)
- More extensive energy and GHG impacts of water distribution and water treatment systems
- Basic and Innovative Treatment Options: Point of use, localized, regional treatment
- Infrastructure for reuse of various levels of water quality
- Utilization of existing analytical laboratories (e.g., Dept. of Energy labs at university campuses (e.g., Materials Research Laboratory at University of Illinois, NIST)

Are we collaborating with the appropriate research partners? Are there other potential partners that we should engage?

- Specified partners are good (select cities, states, consulting firms, academic institutions, nice leveraging,
- Outcomes of international activities from Global Water Research Coalition (GWRC, initiated 2002) should be explained

Additional resources:

- Great to receive CRADA support with SSOAP, but how about Department of Defense, management of infrastructure (SERDP/ESTCP management programs)
- DOE supported material research laboratories (e.g. Fredrick Seitz Materials Research Laboratory, UI)
- NSF-EPA Research Center sounds very encouraging, but there are existing National Science Foundation Research Centers (e.g., Water and Materials Purification Center)
- Broader participation of international and academic institutions
- Remote and multi-point sensing of water distribution and water quality (e.g., WATERS Network, NSF and NCSA)
- International drinking water and wastewater related organizations

<u>Charge Question 3:</u> Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

It was difficult to assess the sequencing that was occurring with the research plan because there was no clear section describing such sequencing except with respect to communications. However, the overall plan to provide national and regional assessments, analyzing "state of technology" and then perform demonstrations is reasonable. It is also important to consider local

assessments seeing that many water distribution systems include a large number of local utilities. EPA should carefully consider how they can leverage future funds with their planned sequencing. It appears that bench-, pilot-, and demonstration-scale research is occurring in series, which is very appropriate. It would also be good to include sustainability, energy, climate change/greenhouse gases, total water management, and communications in parallel when reasonably possible.

Comments from Mr. Michael Selna

General Comments:

The research areas addressed by the program are appropriately configured and are well organized into the four areas, namely, condition assessment, repair/rehabilitation, advanced concepts/innovative treatment, and cross cutting/integrative approaches. Specific comments on the technical programs are contained in the response to each charge question. Generally, I believe EPA needs to dedicate a larger amount of its effort and funding to assessing existing full-scale projects being carried out by utilities and then to create an expanded effort to make its work much more visible to the practicing environmental engineering profession, both consultants and engineers working in utilities. Today, EPA is *not* regarded as a source of technical information. EPA is to be applauded for re-establishing itself as a technical resource at a time when there is greater emphasis on science-based decision making. I appreciate the opportunity to participate in this consultation, which was efficiently conducted by EPA staff and Dr. Dzombak.

Charge Question 1: Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

Review of the technical goals is well covered in the discussion of each charge question. I have chosen to take an overview in response to Charge Question #1 and to focus on what can be done to cause the program to make a **significant national impact.** The program is positioned to contribute meaningfully to making infrastructure management, repair, improvement, and replacement more efficient and cost effective. However, as presented, it will fall short of that goal because it will not be visible to practitioners.

Background- Before the consultation, I polled a few of my contacts in industry and asked the following question: Suppose you faced a technical dilemma, say in the rehabilitation of pipelines or in the design of innovative wastewater treatment systems, would you turn to the EPA as a source of technical information? Younger leaders answered that they would not bring to mind EPA as a source of technical information. But a few us who have been practicing (much) longer remember EPA's position in the early 1970's when the "Technology Transfer" effort was underway. We all had blue binders from EPA with reviews of current design approaches and results of recent research. EPA was in a leadership position.

Recommended Actions: One of the outcomes of the Rehabilitation Technology Forum was that information transfer is a critical industry need. Infrastructure improvement will not occur unless industry practitioners understand the technology and can convey infrastructure needs in simple terms to their constituents and elected officials. EPA could fill an important national gap in education and information transfer. The information needs to reach the practitioner level. This often resides at the local and state Water Environment Federation (WEF) and American Water Works Association (AWWA) member association (MA) level, in terms of appropriate training venues. EPA could work with these trade organizations to organize and fund state level workshops/seminars to be presented by teams of recognized experts. The teams could provide

information on emerging technologies as well as case studies of well-documented full-scale leading edge projects. This is preferable to creating an information center because the main route of exposure is through local/state level training venues. WEF and AWWA MA's and organizations such as the American Academy of Environmental Engineers (AAEE) have established teams of volunteers waiting for relevant topics such as the EPA infrastructure research so that they can move forward with training events. These can be configured on a local/regional one-day scale such that employers are comfortable sending staff rather than to expensive, distant national conferences. I will address how to make this work at low cost and staff time for EPA as well as other outreach tools in response to Charge Q #5. I placed this input here because I believe this is the most important change in direction for the agency if its fine work is to have **significant national impact.**

Moving to EPA's research approach, many of the proposed projects that are labeled as cutting edge are being implemented on a large demonstration scale or full scale by utilities. This is true in the areas of wastewater collection system reconnaissance and rehabilitation and especially in the area of innovative treatment and water reuse. Examples include long-term performance of pipeline rehabilitation projects, performance of innovative treatment systems e.g. Orange County Water District (OCWD) groundwater replenishment project, and full-scale experience with nutrient removal projects. Utility managers would be far more compelled by controlled data gathering and review of these large-scale projects than by the additional pilot scale and soil column studies. This was born out in the output from the Technology Forum from which the following statement was extracted:

"There was a strong feeling that revisiting previously installed rehabilitation projects with a detailed investigation and estimation of deterioration versus as designed and installed condition would be valuable…"

EPA can leverage its resources and produce more convincing results by working with the nation's large water and wastewater utilities, many of which have large on-going research efforts in the same subject areas covered by EPA's proposed infrastructure research. It is recommended that EPA save its research resources for areas not already being addressed by utilities. Possibly the cooperative agreement with WERF will create productive connections with utilities, but I would urge you to also consider direct contact with large utilities that have on-going research programs such as LA County Sanitation Districts, Orange County Water District, and Greater Chicago Water Reclamation District. Much of the research conducted by these utilities is not connect to WERF or WRF.

An overarching observation is that the research programs do not each contain a climate change/sustainability component. Several individual projects do address these critical topics, e.g. Total Water Management and Advanced Decentralized Water/Energy Design. For example, when working on a water reuse research project consideration should be given to carbon emissions, energy consumption, and sustainability of the proposed method of reuse. A sustainability project subcomponent should be created to address these issues.

<u>Charge Question 2(A):</u> Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

Background- My input reflects experience with the LA County Sanitation Districts (LACSD) which serves 5.2 million people. The agency operates and maintains 1350 miles of sewers, 52 pumping plants and associated force mains. System condition assessment and rehabilitation projects are on-going. LACSD owns and operates CCTV equipment and also contracts out CCTV work. Sonar has used to a limited extent primarily to map deposits of material. Infrared has been tried with no success. Ultrasonic is being evaluated for force mains. By far, the best information comes from advanced CCTV.

Forensics of sewer failures and predictive model- It is difficult to conceive this would bear useful results. Conditions are so site specific. Better use of funds would be to help establish warning signs and an inspection frequencies manual. Rates of corrosion would be nearly impossible to model. A better use of resources would be to develop simple indicator tools for use by practitioners based on review of experience in operating systems.

Innovative condition investigation using advanced miro-techniques- If the conditions will support the growth of sulfate reducing bacteria, the bacteria will be present. Wastewater quality and in-sewer conditions are so variable that it is difficult to conceive of this project bearing practical results. That being said, I understand the argument that this work may discover more about the microbial mechanisms on the chance that a strategy could be developed to modify the microbial populations in-situ. With a constant resupply of the ubiquitous bacteria that cause sulfide corrosion in sewers, it is difficult to conceive of a way to constantly modify the bacterial population in a pipeline where 50-100 million gallons per day of new innoculum might flow by. I realize we have developed methods to better control the populations in biological reactors notwithstanding the constant change in substrates, but dealing with thousands of miles of sewers is much different than with reactors in which several critical parameters can be controlled. The better strategy in my opinion is to protect the sewers. Plastic liners should be installed in all new concrete sewers and asset management based decisions should be made relative to lining, maintaining or replacing existing sewers. This project may be analogous to disinfecting great quantities of soil to prevent people from contracting tetanus. It's better to give people shots (i.e. protect the pipe) than to modify the bacterial populations in large quantities of soil people may contact (i.e. billions of gallons of sewage per day).

Asset management guidance and tools- This is where EPA can fill a void by getting this information into the hands of utility managers, especially smaller utilities. EPA brings credibility and stature.

General comment related to both condition assessment and system rehabilitation: The vast majority of the water and wastewater pipeline infrastructure is operated and maintained (or not maintained) by in small "satellite" systems, many of which feed into the nation's large utilities. There is a strong need to get condition assessment, rehabilitation, and asset management tools to satellite system managers, most of whom are public works managers not focused on pipeline infrastructure issues. In terms of miles of sewers and dollars spent on infrastructure, EPA's national impact could be greatest if it develops programs that help satellite system managers cope with their condition assessment and rehabilitation problems. This would require a different

approach in packaging the output. I would suggest working with APWA to assess how EPA can best interact with satellite system managers.

Charge Question 2(B): Comment on whether research on system rehabilitation will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

Recommended Action: Place greater emphasis on systematic review of existing long-established rehabilitation projects using protocols developed by the program. Early dissemination of the results of this work could provide compelling information, especially to smaller utilities, producing a positive national impact early on. Many utilities have extensive experience evaluating and implementing rehabilitation methods. For example, LACSD has been installing and monitoring the condition of rehabilitation materials for the past 20 years.

Areas not addressed in plan: Increasing the longevity of deteriorating wastewater collection pipelines using magnesium hydroxide crown spray systems. This can be a more economical asset management approach than rehabilitation or replacement. LACSD is a source of information on this topic and annually maintains hundreds of miles of large diameter sewers with this technique.

Charge Question 2(c): Comment on whether research on advanced concepts and innovative treatment technologies will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

EPA has done an excellent job of assessing the research needs in these areas. As discussed in response to Charge Q#1, efforts to effectively disseminate the results need to be ramped up for the results of this work to make the national impact EPA desires.

The **Nitrogen and Phosphorous Control Design Manuals** and subsequent seminars are excellent examples of technology transfer that can impact the industry. I would recommend, however, that the seminars be provided on a far broader scale than three regions by the end of FY10. I would suggest a goal of 20 seminars nation-wide to achieve the goal of making a national impact. As will be presented in response to Charge Q#5, there are inexpensive mechanisms to allow this to happen at little, if any, cost to EPA.

Wastewater Treatment and Reuse Treatment Technology Evaluation and Development: This work is broken into three modules: (1) Need for reuse, (2) Water reuse experimental studies and (3) Contaminant assessment during reuse applications.

Module 1: Most regions are not practicing reuse now, but if sustainability concepts are considered, more areas of the nation should be practicing reuse. For example, does a decentralized system with local reuse produce lower energy demand/carbon footprint even in non-arid areas? Large scale decentralized treatment is practiced by LACSD and others. LACSD has 550 reuse sites in LA County. Dual distribution systems are established in a number of CA communities, such as Irvine, CA. Dissemination of information on these projects by EPA would benefit the industry.

Module 2: Many of the experimental studies proposed by EPA are being practiced at full scale in CA, AZ, and FL. The Orange County (CA) Water District Groundwater Replenishment System (OCWD GRS) is a prime example of deployment of advanced membrane and oxidation technologies.

Module 3: Los Angeles County Sanitation District (LACSD)'s Montebello Forebay project has been recharging potable groundwater supplies with reclaimed water since 1961. Numerous studies of removal of constituents in the soil profile and broad health effects studies have been performed. If the primary goal is to change the perceptions of reclaimed water, work should focus on data from successful full scale systems and how best to present information to the public. OCWD GRS has produced an outstanding public information DVD for this purpose and conducted a public outreach campaign that resulted in overall public support for the project, rather than opposition.

Advanced Decentralized Water/Energy Network Design for Sustainable Infrastructure: This project and the **Multi-Scale Infrastructure Assessment** represent the strongest recognition of sustainability and climate change considerations. As discussed in Charge Q#1, this thinking needs to be pervasive in all programs, i.e. there needs to be consideration of sustainability in, for example, nutrient control, sewer rehabilitation, etc.

Total Water Management: This is a great concept. EPA should determine the target audience of the output. How will it be implemented given our political/regulatory framework? Can we get regulatory community to think this way? Are there enough multi-program utilities to embrace this? Can we get function-specific utilities to work together to accomplish this?

Summary Recommendations: Leverage EPA resources by using information from full scale advanced treatment systems and well established water reuse systems to produce compelling information to influence utility managers. EPA is to be commended for establishing cooperative agreements with WERF and WRF. These entities have already established mechanisms for cutting edge research. EPA can fill a national void by producing information on existing systems and disseminating that information in the short term.

Charge Question 3: Comment on whether the following research approach is appropriately designed in sequence to meet program goals: a) national and regional assessments, b) analyze "state of the technology," and c) move "state of the technology" forward through demonstration of innovation.

The proposed approach (technology assessments/analyze state of technology/demonstrate innovation) is logical. The analysis of the state of the technology should strengthen the demonstration projects by eliminating demonstration of technologies that are already being implemented at full scale. (As mentioned in response to Charge Q#2, this is occurring, especially in wastewater treatment technology and water reuse research projects.)

I recommend that there be a significant effort at the conclusion of the technology analysis step to disseminate the results. This will have three beneficial effects: (1) It will place valuable information in the hands of practitioners at the earliest possible date. (2) EPA may receive feedback that will be useful in shaping the demonstration projects, and (3) EPA will gain early recognition as a source for high quality technical information. The latter effect may induce additional funding for EPA's efforts. This needs to be a deliberate and significant effort to share the results of EPA's work with industry at an early date rather than to wait for the completion of the demonstration work.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

EPA is to be applauded for its decision to reach a cooperative agreement with WERF and WRF. I came to the meeting ready to recommend that this be pursued in order to take advantage of the cutting edge research being done by those organizations, leaving EPA to fill gaps in assessing existing technology and to provide widespread dissemination to the industry. I was pleased to learn of EPA's decision at our meeting.

I believe EPA should improve its geographical distribution of research projects. Much of the advanced work in the areas of wastewater treatment technology and water reuse is being done in California, Arizona and Florida, yet little, if any, of the research is proposed in those locations. Several large agencies have significant research efforts underway which could be leveraged by EPA. (LACSD has a research staff of about 20 engineers, for example.)

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

Utility managers answer to state and regional regulatory officials who may not be exposed to the infrastructure research results produced by EPA. Often, progressive work by utilities is stifled simply because regulatory decision makers cannot stay abreast of the latest developments, which may be no fault of their own given their workload and training. EPA could have a significant cost saving impact on infrastructure management by providing more training opportunities for state and regional regulatory officials. The results of EPA's work could act to make state and local regulators more comfortable with new infrastructure approaches. EPA's work would be viewed with credibility by this important group within the industry. Perhaps EPA could conduct this training within its regions as opposed to attempting to transport representatives from 50 states to EPA; the turnout and impact would be far greater.

As discussed in Charge Q#1, EPA can reach its national impact goal only if its dissemination efforts are significantly increased. The outreach plan is good work but needs to be ramped up to a much higher level. This can be accomplished at little cost and staff time if EPA will work with organizations such as AAEE, WEF, and AWWA, which have workshop and seminar expertise. These organizations use volunteers to make local arrangements. Employers have expressed a desire for one-day regional (within states; I am not referring to EPA regions here) training events to control costs. EPA could train the trainers who would conduct the events. The manuals and technology assessment results can be provided to industry efficiently and on a wide spread basis through this approach. I can personally volunteer AAEE to conduct four or more events of this type per year in cooperation with EPA. Web casts were mentioned as a possible tool, which I believe has merit. However, these should not replace the proposed physical workshops because so much is lost when there is not an opportunity for face-to-face collaboration.

Comments from Dr. John R. Smith

Overarching Comment

If we believe that the cost of aging water and wastewater infrastructure represents a budget shortfall in the "$500 billion in 20 years," range, then my key comment relates to the fact that the technology R&D budget to address this is well underfunded at the $5 million/year range. To help focus scarce recourses on a R&D program to achieve safe water supply and effective wastewater management at a significantly reduced cost than what is cited above, there needs to be an overall national water strategy so that we are all rowing in the same direction. I realize that this is not the intent of the ORD water effort, but such is needed for their program to be focused and effective. When the Clean Water Act was first announced, it provided a very clear strategic goal aimed at effectively treating all the point discharges from both industry and municipalities, with storm water only discharges not specifically addressed at that time. To this end, there was a strategic focus and goals supported by a three pronged approach to achieve them. This three key elements of the approach included: 1) Strong enforcement with every point discharge requiring to meet a discharge permit, 2) A well funded science and technology program to spur innovation in water supply and wastewater treatment, and 3) A mechanism to assist municipalities in funding the water/wastewater infrastructure needed. This program was very successful and resulted in our water ways being cleaned up. Now we are faced with the challenge that these same systems installed in the 1970's and 1980"s are antiquated and in need of repair or replacement. Furthermore, to compound this issue, we also want cleaner water being discharged than previously strived for as well as realizing that certain areas of the country are facing severe and extreme water shortages that may only get worse in the future. As we can now detect chemical in the low parts per billion, parts per trillion and even the parts per quadrillion levels vs. the earlier part per million levels, innovative science and technology is once again needed to meet such requirements at lowest cost in both wastewaters and storm runoff.

While the Clean Water Act is still the foundation of a national water strategy, we need to better articulate and agree upon a common lowest cost approach to continue to move to "Zero Discharge of Pollutants," as cited in the Clean Water Act; i.e., do we continue to enhance the central treatment system approach and fix-upgrade the current piping infrastructure or do we begin to look at greener approaches for wastewater treatment/reuse and storm water management. Such a clear strategic focus is missing and thus the water R&D program is doing a bunch of one-off projects that will serve to provide some assistance to certain situations but it will miss the mark of having a significant overall impact. To be effective, an R&D program must be focused on developing and delivering the technologies to move toward a true north, addressing immediate problems as appropriate but doing so that you are constantly moving toward the true north goal. At present there is no true north as there was in the early 1970's as well as the necessary budget to get there. The current water R&D program is doing the best it can at present, but could be so much more effective with a well articulated true north followed by the financial support to get there.

<u>Charge Question 1:</u> Comments on major goals of aging water infrastructure program, including: a) whether program is focused appropriately on major water infrastructure technical issues, and b) what refinements could improve program effectiveness.

The EPA's Water Supply and Water Resources Division within ORD should be applauded for the R&D program they have established and are carrying forward with limited resources. However, in answer to the charge question item asking if the program will "make a significant national impact on the major technical issues facing our aging water infrastructure," the answer is not so clear. While the different projects with ORD do focus on both current and future needs, I struggle to see how they are or will be integrated to achieve the needed outcome. One way for this integration to be done is to use the results of all the different elements of the R&D program to develop a roadmap or decision tool to be used by respective stakeholders and decision makers for all the various items to be considered so that the right total water management approach is developed for a particular situation including cost analysis. In developing this integrated tool, data and information generated by the R&D program should also be supplemented by that already generated and present in the literature as being done by others, both in the US and worldwide. Such a tool will help serve to facilitate decision making at regional and local levels, as well as serve to support the lower cost approaches being demonstrated under the Advanced Concepts and Innovative Technology areas of the program.

<u>Charge Question 2(c):</u> Comment on whether research on advanced concepts and innovative treatment technologies will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

Building upon my comments above, I applaud EPA for initiating the "advanced concepts and innovative treatment technologies" program and strongly believe it will result in tangible outputs and outcomes. This especially relates to the green technology area related to storm runoff control in urban areas. By demonstrating such technologies on a sound scientific basis will serve to help accelerate acceptances of these lower cost technology approaches by others as well as give regulators the confidence to permit such approaches. While the pilot work and testing being done at Edison will serve to demonstrate such green technology approaches, the real proof will be working with local municipalities to get these green type technologies deployed where the results can be quantified and more importantly demonstrated on a full-scale for other municipalities to learn from and also not be apprehensive to pursue as more and more locations install such green approaches. During the meeting, EPA is beginning to do this and encourage more of it. Also, focus should not just be on urban areas, but also consider working with small rural communities, developers and industry as the need is also there for lower cost "green technology approaches." To truly achieve the goal of the Clean Water Act, I am reminded of a quote by Rita Mae Brown who defines "Insanity as doing the same thing over and over and expecting a different result." In this regard, EPA is on the right track with the green technology approach as I feel it does represent a different approach that will help us more to true water sustainability at lowest cost and thus help close the $500 billion gap.

<u>Charge Question 4:</u> Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

Regarding "whether ORD is collaborating with the appropriate research partners," I give them a gold star. Here, ORD is well engaged with the EPA regions and have collaboration efforts ongoing with WERF, contractors/consultants, utilities, and have initiated various "green technology" projects with Kansas City. Others who may be interested in helping to demonstrate lower cost sustainable water approaches include builders and developers, manufactures who supply green technology products, entities such as Wal-mart and BP who may want to enhance their sustainability image, and industry. Also, broadening beyond the US is also recommended especially in Europe and Australia where there is much focus on sustainable water infrastructure.

Comments from Dr. Vanessa Speight

Overall

The research program presented is ambitious and highly important to the future of the water industry. The general organization and goals of the research program seem appropriate. The program could be strengthened through the development of a roadmap that clearly shows the timeline associated with different projects, expected outcomes, and linkages between projects.

EPA is in a position to be a technology leader in the aging infrastructure field so should look for ways to conduct research into new frontiers, rather than just supporting the status quo. While I see some value in demonstrating technologies developed by outside vendors for condition assessment and infrastructure rehabilitation, I would recommend that EPA focus more on understanding key performance measures associated with the technologies, identifying barriers to implementation, providing data collection and compilation among water utilities, supporting national assessments, and leveraging its talent and resources to further advance these important technologies.

Charge Question 2(d): Comment on whether the cross-cutting, integrative research on water infrastructure will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals.

The cross-cutting research program presented appears to be aligned with the outcomes for the Aging Infrastructure Research Program. The term "cross-cutting" may not accurately describe the type of research that was presented in this category. It seemed that the projects in the cross-cutting category are fundamental research projects that provide a foundation for much of the research program. The research conducted in the cross-cutting category is of great importance, not only for aging infrastructure but also in other areas such as public health risk mitigation for the water industry. Therefore, EPA should strive to make this research highly visible as an example of its technological leadership.

The linkages between the cross-cutting research and related applied research projects should also be more highly emphasized. EPA should also consider a re-evaluation of the fundamental research needs to support the aging infrastructure program to make sure that the cross-cutting projects are covering the necessary background.

Several of the proposed research projects in other categories (e.g. advanced concepts) could also be considered to be "cross-cutting". These include projects related to data management and decision support systems. EPA should consider reorganizing the research program to more accurately reflect the role of the cross-cutting research projects.

Charge Question 4: Comment on whether ORD is collaborating with appropriate research partners, and whether other potential partners should be engaged with.

There was considerable discussion about the potential research partners for collaboration. I think that the most important issue related to research partners is coordination, not collaboration. The research program staff needs to be communicating with a wide variety of partner organizations to ensure that they are not duplicating effort or pursuing topics that have been proven infeasible by others. It is not necessary for the success of the aging infrastructure program to be actively collaborating with those other organizations, just to be tracking advancements by others working in this field.

Charge Question 5: Comment on whether ORD is engaged with appropriate stakeholders to attain Aging Infrastructure Research Program goals and to transfer results to appropriate users.

The research program has an extensive list of partnerships and stakeholders identified as well as an impressive communications plan. However, the program is still relatively unknown among practitioners in the water industry. Therefore I would conclude that considerable outreach work remains to be done for this research program.

I think that a key element for successful outreach will be to tailor the technology transfer to the specific needs of the stakeholder group. For example, small water utilities may need simplified tools and guidance to address their aging infrastructure problems. Large and more complex water utilities will not be able to use such simplified tools but have staff available who could work with EPA to customize the tools. It is important that this program not try to support all possible stakeholders and collaborators but rather to focus on some key wins.

Comments from Dr. Michael K. Stenstrom

I enjoyed the meeting and I thought it was successful. The programs being conducted are impressive.

I am transmitting some thoughts and suggestion regarding the presentations made at the SAB meeting on July 21 and 22 in Cincinnati. I have attached my "talking notes" for my two discussion leadership areas. The rest of this letter summarizes the questions and comments made during the discussion periods. I made perhaps 75% of the following comments at the meeting. I have fine-tuned some of them as I wrote them down.

1. In the sewers-monitoring and corrosion aspects of the program, I think it is important to link the owners' stewardship with assessments of sewers. In my career, at least over the last 10 or 15 years, I have had many opportunities to visit treatment agencies. The operators/owners' stewardship of the facility may have as much impact on the conditions of the sewers as construction materials and wastewater characteristics. I have seen various types of equipment work really well in some agencies and fail miserably in other agencies. The worst problems with infrastructure management have occurred when local government fails. I do not want to mention specific examples but some of the large cities would be good examples. It is usually not that the technical people do not want to maintain the infrastructure; they do not get support from their top managers/politicians etc. Creating metrics that the technical people can use to define support needs and justify costs could be very helpful in improving maintenance and preserving infrastructure. Developing resources for technical staff to convince their management to support maintenance programs is warranted. Examples might be cost per mile of sewer or some similar metric.

2. Odor is the "tail that wags the dog" at treatment agencies. The worst sewer corrosion problems are usually associated with odors and septic sewage, and highly septic sewage usually creates other treatment plant problems. Associating sewer maintenance with odor reduction is a way of creating support from management for maintenance.

3. Spills and stormwater management have stimulated sewer maintenance. The NRDC sued the City of Los Angeles over a long history of Sanitary Sewer Overflows (SSOs). Because of the lawsuit, the City suddenly found funds for sewer maintenance programs. The crux of the lawsuit centered around how much funding is reasonable for sewer maintenance. In the late 1970s the EPA published reports with construction costs, based upon the information obtained from surveys of grant funded projects. A similar report on sewer maintenance costs would be useful for agencies to define the minimum they should be spending on infrastructure support.

4. I am not familiar with sonic sensors for sewer leak detection. I have had a little experience with their use in underground storage tanks. It may be that there has been an integration of the technologies, but it might be worth while for someone to determine if leak detection technology in storage tanks has any utility for sewers.

5. In Los Angeles and most places in California, separate sewers are the norm (San Francisco is the exception). Therefore we have not needed to improve sanitary sewers to avoid Combined

Sewer Overflows (CSOs). It intrigues me to think that the environmental momentum for LID technologies and stormwater management could be used to motivate more funding for sewer maintenance. LID technologies almost always reduce runoff volume and peak flow rate.

6. I made the point that corrosion science is almost totally absent in environmental engineering education. We environmental engineers make a lot of stupid mistakes that result in excessive corrosion. This occurs in treatment plants as well as in collection and distribution systems. I believe AEESP could be an excellent vehicle to develop an educational program for environmental engineers. The American Academy of Environmental Engineers (AAEE – Mike Selna is active in this organization) advises ABET on accreditation requirements. Both organizations would encourage the development of course materials for applied corrosion science. The problem with existing corrosion education at universities is that is far too advanced and specialized for the needs of environmental education

7. I very strongly encourage the EPA to publish their success stories in peer reviewed journals. These publications have a more profound impact on the academic community than reports and proceedings. They result in archival documents and the process of creating the journal article and suffering through peer review results in the distillation of a complex report into ~10,000 word concise document. It will require staff time that will take away from other EPA efforts. It may seem that such publications are not necessary since there may be widely circulated reports covering the same topics, but I assure you that these journal papers will be a long lasting contribution to further EPA's goals.

8. I have a former student named Carmen Lee who works in asset management (AM) for the Sacramento Regional Treatment Agency. She says that her agency has profited from the EPA's training efforts. All my experience with this agency suggests that they are anxious to work at the forefront of technologies and would be a good partner for the EPA in any research or demonstration projects.

9. I am pleased that the EPA is supporting research on emerging pollutants such as endocrine disrupters. I teach an advanced graduate class and each year we pick a subject to review. This year we picked biological treatment of emerging pollutants and it was easy for the students to find literally hundreds of recent papers on degradation rates (or lack of degradation). Many if not most of these pollutants are degraded or removed in biological treatment plants operating at longer sludge retention times (SRTs). This phenomena provides an incentive in addition to nutrient removal to operate treatment plants at longer SRTs. The recent work of my group has shown that the conventional wisdom that longer SRT operation requires more power is wrong – the higher alpha factors associated with longer SRT and the stoichiometric benefits of denitrification more or less equalize the aeration power requirements of low and high SRT operation. It may be time for the EPA to target its funding to the next phase of this work -- improved plant operation as well as product substitution. Two examples of emerging pollutants that are not well removed in biological treatment are radio opaque chemicals used in radiology and antispasmodic drugs. Finding substitutes and biological treatment plant optimization might avoid or reduce the need for energy intensive-treatment such as RO.

10. I believe that full-scale technology demonstrations are usually the most convincing proof that a new technology works. Unfortunately they are often not as useful for understanding the theory or principles of why the technology works. I think it is important to avoid full scale demonstrations that are not ready. Some treatment agencies, due to their labor rules and inability to write purchases orders and subcontracts in a timely fashion, are unable to do small scale work. If management wants to do a test, they are often forced into a full-scale test so that they can use part of the existing plant infrastructure, operators or laboratory resources. Operators are usually not so interested in testing that increases their work load and labs optimized to do routine monitoring are often not well suited to support research. The result may be a poor demonstration or a "black eye" that has the exact opposite of the desired impact – impeding the introduction of the new technology.

11. The Ventura County Municipal Stormwater Permit will require the use of cisterns for new construction to manage stormwater runoff. There is an opportunity for the EPA and others to observe the impact of cistern use, successes and failures. A particular challenge for this permit and cistern use is the seasonality of rainfall (Mediterranean Climate, 99% of the rain is from November to March). This will require cisterns to be larger and to hold water beyond the normal rainfall period, and will be dry for perhaps more than half of the dry period. It is not an ideal location for cisterns. As I mentioned at the meeting, Eric Strecker of Geosyntec is familiar with the permit.

Charge Question 2(A): Comment on whether research on condition assessment will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

1) CCTV of sewers is a pretty well developed technology. I am sure that there are ways to improve existing methods, although the details or techniques are so specialized that an individual "away from the trenches" is unlikely to know what improvements are possible. The State of the Art Review cited would not be a traditional "paper" literature review but interviews with agencies – some selected because they are leading edge in this area and some because they have done little and can allow a team to judge their needs.

2) Some thoughts about alternative inspection systems: Nano technology and imbedded wireless sensors have been proposed to float through sewers collecting data to be used for maintenance. Real-time recording of pH, conductivity, ORP or even photography can be considered. They are loaded at one point in the sewer and collected at a downstream point.

3) Forensics of sewer failures. Seems like a worthwhile effort but maybe it is not a major project? I believe we already know a lot of the forensics. Perhaps this should be viewed as an "add-on" to what we know, as opposed to a major thrust.

4) I am not sure of technology in other fields and its applicability to water and wastewater, but I think there is already some effort to develop nanoscale sensors for water and wastewater.

5) I am reminded of a program in LA, sponsored by the LA County Sanitation Districts, where several research groups looked at various aspects of concrete sewer corrosion. We looked at gas transfer, USC (Joe Devinny) looked at wetting the sewer crowns, LACSD looked at oxygen

injection. A group at CalTech looked at adding a phage to disable the H2S oxidizing organisms. I think a survey to determine the microbial ecology of sewer crowns might be a good approach. One might find variances that could be related to the extent of damage, or through better knowledge of the ecology, propose microbial controls.

Under asset management, I think we should consider the rate of return on our investment. Often, we assume a 20 year life cycle on treatment plants. Certainly this might be an appropriate window for rotating equipment, but certainly not for sewers. A 100-year payback might be appropriate for sewers. In a sense, we are living today with short sited decisions of the past. We have used short periods of return – in effect trying to limit the cost of our investments. Longer term benefits should be used to justify greater investments.

Peer review publications . I know it's a time consuming thing and it is hard to know the impact, at least the short term impact but I think it's very important.

Sequential vs. Parallel Approach – generally good approach but some exceptions, such as education and tech transfer. I think is best to assume a sequential approach but to not be hamstrung by the approach, if an opportunity for a new activity becomes available.

GIS is an essential tool for maintenance of collection or distribution systems. It has not been as widely implemented as it should. Smaller agencies may not be able to afford it and big cities are sometimes too bureaucratic to work quickly.

Charge Question 2(c): Comment on whether research on advanced concepts and innovative treatment technologies will result in tangible outputs and outcomes that will support Aging Infrastructure Research Program goals

Microbial ecology of sewers: Even though my colleague from LACSD is doubtful that we can change the ecology, I still think it would be useful to continue research in this area. Firstly, it's not a lot of money compared to the investment in collection systems. Secondly it is a way to engage the academic community in this area. I point to the example of activated sludge microbiology. Before, it was a "brown box," and things worked or they didn't. An improved understanding has led to selector technology and several other process improvements that have increased the stability and reliability of activated sludge treatment plants. I believe microbial ecology is an important area, and I suggest we proceed and have faith that what we learn things will be useful for application.

Using the environmental interest in stormwater management to create less runoff is a strategy that holds promise. For communities with combined sewers, one can build equalization, larger treatment plants, or one could reduce runoff with LID, etc.

Support the odor control manual. Corroding sewers are odorous sewers.

It may be my perception, but the effort going into new treatment technologies is really large compared to the other areas we have discussed. Therefore I see the EPA's role differently. In the case of aging infrastructure, the EPA has to be a driver, a stimulator. For advanced treatment

for reclamation, nutrient removal, emerging pollutant removals, there is a lot of effort ongoing and permit compliance is the driving force. The EPA is almost an observer. Perhaps it's due to the stimulus – an agency doesn't get fined if they have 2 mm extra corrosion in their trunk sewers. Design manuals are good and will have an important impact. The EPA needs to selectively focus its efforts to "fine tune" the process.

Energy conservation concepts need to be integrated into treatment plant design and operations. Safety of reclaimed waters – maybe there is a role for the EPA to play, as a higher authority to help overcome perception problems as well as increasing the safety of reclaimed waters.

Enclosure 3
EPA Charge Questions to the Committee

June 29, 2009

MEMORANDUM

SUBJECT: Consultation on the Aging Water Infrastructure Research Program

FROM: Sally Gutierrez, Director */signed/*
Office of Research and Development
National Risk Management Research Laboratory

TO: Vanessa Vu, Director
Science Advisory Board Staff Office

This is to request that the Science Advisory Board (SAB) Environmental Engineering Committee (EEC) conduct a consultation of the Office of Research and Development's Aging Water Infrastructure Research Program.

Background

In support of EPA's Sustainable Water Infrastructure Initiative, the Office of Research and Development (ORD) initiated a research program in 2007 to improve and evaluate innovative technologies and techniques for reducing the cost and improving the effectiveness of operations, maintenance, and replacement of aging and failing systems for drinking water and wastewater treatment and conveyance. The outputs from this research program are intended to assist EPA's program and Regional offices to implement Clean Water Act and Safe Drinking Water Act requirements; to help States and Tribes meet their programmatic requirements; and to assist utilities to more effectively implement comprehensive management of drinking water and wastewater treatment and conveyance systems, provide reliable service to their customers, and meet their statutory requirements. ORD's 2007 Innovation and Research for Water Infrastructure for the 21st Century Research Plan (600/X-09/003) proposes work relating to infrastructure condition assessment, system rehabilitation, infusion of advanced design and management concepts, and evaluation of innovative treatment technologies. ORD's 2007 Innovation and Research for Water Infrastructure for the 21st Century Research Plan (600/X-09/003) is available on the following web site: http://www.epa.gov/awi.

Specific Request

ORD requests that EEC provide advice on whether the program goals, research focus areas, research approach, research partners, and communications and program interactions are properly directed to have a significant national impact of the major technical issues facing our

nation's aging water infrastructure. Specifically, ORD asks that the EEC address the following charge questions:

Consult Charge Questions

1. The two major goals of this program are to:

   generate science and engineering to improve and evaluate innovative technologies and techniques to reduce costs and improve operational efficiency, maintenance, and replacement of aging and failing drinking water, wastewater treatment and conveyance systems; and

   assist EPA's program and Regional offices, States and Tribes to meet their program requirements, and assist utilities to more effectively implement comprehensive asset management, provide reliable service to their customers, and meet their Clean Water Act and Safe Drinking Water Act requirements

   Given these goals, is the program appropriately focused to make a significant national impact on the major technical issues facing our aging water infrastructure? Could the program goals be refined to improve program effectiveness?

2. Are the research focus areas (condition assessment, system rehabilitation, advanced concepts, and innovative treatment technologies) and the related cross-cutting research likely to result in tangible impacts that will support the program goals? Do the program activities and projects appropriately support the current program goals or are additional activities or projects necessary?

3. The sequential research approach of the program is designed to develop national and regional assessments, analyze the "state of the technology", and move the "state of the technology" forward through innovative field demonstrations. Is this sequential research approach appropriate to address the goals of the program? Is the program's concentration on infusing innovation through field demonstrations appropriate?

4. Are we collaborating with the appropriate research partners? Are there other potential partners that we should engage?

5. Through our communication and program interactions, are we engaged with the appropriate stakeholders to understand the research needs in this area, attain the goals of the program and to transfer the research and technology demonstration results to the appropriate users?

If you have any questions about this request, please contact Dr. Thomas Speth, Acting Division Director, Water Supply and Water Resources Division at Speth.thomas@epa.gov or 513-569-7208.