GOAL 2

CLEAN AND SAFE WATER

Strategic Planning Futures Workshop
28 October, 2005
Summary Report

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Purpose of Workshop

To facilitate the integration of futures analysis into agency strategic planning, EPA held this workshop with the Goal 2 planning team to support the consideration of emerging issues that are likely to affect environmental quality and have lasting impacts on the Agency's ability to achieve this Goal. While it may sometimes be difficult to connect thinking about the future to daily work, it is important to take time occasionally to consider emerging developments. However, this may be an opportune time to begin thinking how emerging technologies can improve both water programs and water data.

During the time period leading up to the current strategic plan revision, OCFO identified 11 potential emerging issues related to Goal 2 through consultations with the following groups: Innovation Action Council, National Council for Science and the Environment, ECOS, National Tribal Conference on Environmental Management, Woodrow Wilson Center, and Institute for Alternative Futures.

These 11 issues were:

- Global water scarcity;
- Water quality and quantity becoming more prominent issues, and are more interrelated, including diminishing groundwater and recurring drought cycles;
- The nation's drinking and wastewater management infrastructure is decaying; at the same time, innovative technologies for water management are emerging, along with an understanding that water reuse and associated quality issues are linked to water quantity issues;

- Growing concentration of pharmaceuticals in wastewater with an aging population; possibility of "hot spots" in popular retirement areas
- Progress in sensor technology; distributed sensor networks;
- Biotechnology/Nanotechnology/Ecological design for bioremediation (polluted streams, lakes);
- Use of DNA arrays and other genomics methods to identify vulnerable sub-populations – potential impacts on water quality standards;
- Environmental terrorism targeting public water supplies and water and wastewater infrastructure;
- Ocean pollution/degradation;
- Planning preventive strategies or responses to predictable effects of climate change such as sea level rise, salt water intrusion into aquifers, changes in estuary boundaries;
- Comprehensive coordination of EPA roles related to water to set high, attainable standards, address the loss of aquifer resources, and achieve a better integration of land use planning with efforts to protect water quality.

The five following issues were the basis for the Goal 2 workshop, with presentations and discussions addressing their potential meaning to EPA's water program and to future environmental quality:

1. Pharmaceuticals in Water
2. Remote Sensing technology
3. Water Scarcity
4. Managing in Times of More Limited Resources
5. Nanotechnology

Discussions around these issues were informal and preliminary. The ideas generated should not be viewed as commitments for new work. Any of these ideas would need further development and evaluation before any new work is begun.

Speakers

Robert Olson
National Advisory Council on Environmental Policy and Technology (NACEPT), Institute for Alternative Futures

In a presentation entitled, "Why Think Ahead?" Olson discussed past revolutions in industrial technology and argued that EPA was created "facing the past" with responsibilities for dealing with the damages caused by an aging technological order. Now, however, a new revolution in industrial technology is underway, based on emerging developments in areas like materials science and nanotechnology, biotechnology and genomics, information, communications, and energy. EPA needs to devote more resources to "facing the future": understanding emerging technologies, heading off potentially serious environmental problems they could pose, and helping to steer their evolution toward a more advanced technological order in harmony with nature.

There are many serious emerging problems in the area of water, including the extensive overpumping of aquifers internationally and domestically, the decaying infrastructure for both wastewater and drinking water, and the increasing levels of pharmaceuticals and personal care products in wastewater. Emerging technologies that could help to solve these problems deserve greater attention. Nanomaterials, for example, may prove important for water treatment, filtration, desalinization, and site remediation. DNA arrays and networks of advanced sensors can allow real-time monitoring of water quality.

Today's work is a first step in meeting the challenge posed by NACEPT to "*incorporate futures analysis into strategic planning*" and the challenge set out earlier by the SAB to "*Begin to anticipate future environmental problems, and then take steps to avoid them, not just respond to them after the fact*."

Richard Sustich
NACEPT, Center of Advanced Materials for Purification of Water with Systems, University of Illinois

The NACEPT report, *The Environmental Future* (http://www.epa.gov/ocem/nacept/reports/pdf/2002_09_epa_nacept_pub_final.pdf) presents a way to think about water issues. It identifies the long-term desired state for water and then specific steps needed to reach this state. That is a more powerful way of thinking than starting with the present state and planning a few small steps of change beyond current activity.

Between now and 2025 worsening water scarcity will affect populations worldwide and will become a major issue in most states in the US. The status quo simply is not sustainable and today's problematic institutional arrangements for water management must change. Accurate water pricing is needed to encourage conservation and investment, and Sustich argued that the EPA has an opportunity to spearhead economic research for "true cost pricing," including the connection between energy consumption and water. [Later discussion also highlighted the challenge of how to include the ecological value of water, making the connection to the ecological services that water provides.]

He also points out that we are in the "Replacement Era" for water infrastructure – and we have an imperative to do it right. Very large investments will be required. Simply replacing or expanding "what is" will not be enough. Several areas of change need to be pursued including: 1) meaningful conservation, 2) water reuse, both direct and indirect, 3) new and marginal sources of water. There is a large potential for safe water reuse. Although we have water reuse standards, other considerations lead to lack of economic market for reuse. Singapore has a well developed water reuse strategy that should be examined.

Leading-edge research and emerging technologies need to be marshaled to create more advanced water systems. There are potential research roles for EPA in areas like adsorption and binding research, especially contaminants and reaction of contaminants to substrates. Emerging technologies to evaluate include catalysts, sorbents, filters, and membranes to address problems of excess salinity, toxics, microbial contaminants, etc. There is a need for a coordinated knowledge transfer effort across the current horizon of promising technologies from varied research institutions and for efforts to "optimize the pipeline" for superior technologies.

David Rejeski
Foresight and Governance Project, Woodrow Wilson International Center for Scholars

There is a comfort zone for typical strategic planning where highly probable outcomes occur at a steady pace – and the speaker urged Goal Team members to challenge each other to think beyond this zone. It takes determined efforts to garner public and political attention to problems that involve slow rates of change, like aquifer depletion and climate change. On the other hand, it is hard to keep up with the kind of rapid advances occurring in some area, such as information technology that is creating new opportunities. Rejeski displayed a new sensor about the size of a thick quarter capable of detecting a wide range of chemicals. He argued that low price sensors will revolutionize the ability to bring the lab to the water and provide rapid response water monitoring with internet-based data transfer and real-time mapping. He suggested new information-based strategies such as using podcasts for environmental education. An "adaptive planning" approach is needed to deal with uncertainties, rapid change, and the possibility of encountering "black swans" – highly unlikely but possible and "game changing" developments.

Office of Water Background Presentations

There were informal background presentations on the five issues, followed by open discussion. This section touches upon some of the highlights. These are not meant to be final analyses of these issues, nor commitments for specific activities. The discussions were designed to be of an exploratory nature.

Pharmaceuticals and Personal Care Products in Wastewater

Overview

This presentation on pharmaceuticals and personal care products (PPCPs) highlighted the scale of this issue area in terms of the shear number of products that could be included and therefore the extensive research needs required to overcome the paucity of firm knowledge on most compounds. The biggest impacts are probably ecological, but the true scale and range of adverse ecological and human health effects are difficult to determine. For example, behavioral impacts are very hard to detect and observe in ecological systems. Many of these products are PBTs, and that it is essential to look at both active and inert ingredients, which can have unintended biological outcomes. One possible trend is the emergence of antibiotic resistant organisms as antibiotics spread through the environment.

The main pathways of PPCP contamination include human and livestock excretion, CAFOs, and aquaculture. Disposal of unused pharmaceuticals represents a relatively smaller portion of the total, in comparison, but may be easier to address. Upwards of six federal agencies and many international organizations (e.g. EU, WHO) and countries (e.g. Sweden, Germany) are researching and making policy in this area. Additionally, OW & ORD participate in a PPCP Interagency Task Force assembling studies of sludge, bio-solids, endocrine disruptors, etc.

Discussion

- At this time, aquatic ecosystems demonstrate the strongest response to these toxics. What are the impacts of low-level toxics on ecosystems?
- We have spot data but we do not have data that is uniform across classes of compounds. There is a lack of consistent monitoring.
- Some drinking water technologies may be effective in reducing the impacts of these products. Are there classes of products that respond to existing treatments?
- One area of concern is the impact of pharmaceuticals on biological drinking water treatment, such as the bacteria in facilities.
- How broadly distributed are they? How large an area? Should we just be concerned with areas of outflow?
- Would reuse exacerbate this problem? Does this impact the prospects of water reuse?

- There is a paucity of data on metabolites. Currently we are really only looking at parent compounds and assuming they remain stable, not looking at breakdown products.
- We are focused on figuring out the impact of individual compounds but have not yet addressed the potential synergistic effects of multiple compounds on humans and ecosystem health.
- Bioaccumulation up to fish is an important issue, as we are seeing more cases of fish feminization and estrogenic-like activity.
- In OST, we see the potential for certain compounds to be detected in fish due to bioaccumulation, although their aqueous concentrations are relatively small. Our first approach is to look for compounds that we can detect and understand their aqueous fates.
- USGS methods are being modified with some consideration of how they may be put into the Unregulated Contaminant Monitoring Rule (UCMR) Contaminant Candidate List (CCL). This is in order to rule them out or include them.
- For biosolids, we are examining PPCPs by studying the outflows of 7 cities to track locations and determine if this is or is not a problem.
- Meat products are known to have them, while for plant products it is unknown and may not be tested currently.
- Food concentrations of many contaminants vary by orders of magnitude from aqueous concentrations.
- 78 compounds are being monitored in water programs. Also there is activity within EPA to look at biosolids for hormones and other compounds.
- There is a potential for outbreaks with ecological impacts as a result of microbial resistance.
- Also of concern, ongoing fish feminization, detection of endocrine disruptors, and also antibiotics, have the potential for deleterious ecological effects and will be likely targets in the near future.
- This set of information is a classic set up for pollution prevention. We ought to consider strategies that might fall under that component. Many of these products are reviewed by the government prior to their use. We have an opportunity to influence this and engage with federal partners.
- We know FDA does limited assessment on ecological impacts but in the past we have not been able to access this data.
- For PPCPs, there really is not an agency to target because they are not as yet regulated.
- On Pollution Prevention, some materials, like titanium oxynitride (TiON), may be developed and used for consumer point-of-use deactivation in high-risk pharmaceutical applications but may not be appropriate or warrant widespread use for over-the-counter products, or products perform well with a substitute.

Remote Sensing Technology

Overview

The Water Sentinel project is a contamination warning system being piloted in 2006. Water Sentinel is, in a sense, a model of an excellent monitoring system for water utilities. Terrorism detection is the motivating force, but is only one facet of what the system can do. The project seeks to reduce the vulnerability of existing drinking water distribution systems, which are the most vulnerable part of the water infrastructure. Essential needs to secure a system's integrity include contaminant-specific monitoring, an ability to receive and quickly process consumer complaints, as well as public health surveillance for emergency response. Other technological advancements such as online water quality monitoring, and enhancements such as cameras can further bolster existing infrastructure.

Continuous water quality monitoring will provide insight into the treatment process to determine the occurrence and implications of water variability. Currently, 13 different contaminant classes are detected by different sensor methods and there is a need for new methods for measuring a broader range of contaminants. Key related issues include the limits of existing regulations and the need for early warning systems that meet standards of feasibility, cost effectiveness and reliability.

Discussion

- The Water Sentinel vision, if it is feasible economically, is a model for all utilities, regardless of security, as an ongoing management tool and the standard practice in the industry.
- Security is important but certainly the ongoing operations and maintenance could greatly benefit. The sentinel program will encourage links between public health and the utilities.
- Need credible estimates of the time in the future when a distributed sensor network is actually feasible. Through the Sentinel pilot, may take a large step in this direction next year. We'll have data "flowing" into a central system. With contaminant-specific sensors, we face some technological challenges but major progress is possible soon. For pathogens, we may need more time.
- Most of the components are relatively cheap and will become cheaper quickly. Given overall need to upgrade water infrastructure, not clear what level of priority this kind of monitoring will receive.
- Possibility of "smart pipes" that contain the network of chips to provide a sophisticated network?
- Smart materials, multi-functionality is a growing possibility in other media such as photovoltaics that double as structural roofing material.
- Fresh on our minds from Katrina, do we need to review our risk calculations to better assess risks from climate change?
- The Bioterrorism act did require systems of 3300 people or more to establish a plan for emergencies, natural disasters and we are looking to make this more robust.

- These sensors could get us closer to outcomes, rather than interim outputs which we currently deal with more frequently.
- This could support consumer awareness such as direct notification of the public.
- Remote sensing may provide an opportunity for regulatory innovation: we could give people regulatory flexibility if they go down the continuous monitoring route.

Water Scarcity

Overview

The main drivers of increasing global water scarcity include population growth, development, reductions in natural storage, and possibly, climate change. Given links between water quality and water quantity, EPA needs to address how the impending dearth will affect clean drinking water, viable aquatic ecosystems, and agriculture. Since up to 36 states may face water shortages by 2013 in non-drought conditions, it is likely that we will see water rights issues come to a head in the short-term. Severe water depletion can lead to more expensive and drastic effects such as salt-water intrusion while aging infrastructure adds even more pressure to address these concerns in a timely manner. Creating desalination and water purification roadmaps may indicate where we need to go with technology since developing new sources is even more expensive.

Discussion

- Since most water is used for agriculture, not urban uses, taking marginal lands out of production, and using water more efficiently could have major potential to reduce water scarcity.
- Will biofuels influence the marginal land issue? Right now, we don't have any specific objectives, limitations or studies related to ground water withdrawals. Considering the impact on our existing standards, is there a way of getting at the next level, getting to interim outcomes related to watershed measures.
- The USGS has been the main source of data on water quantity, production and use of water, and we've discussed greater sharing of data, but we don't have a direct responsibility here.
- At a recent hazardous algal blooms meeting, there was a discussion surrounding this subject of how water quality is related to flows.
- EPA's pollution prevention objective includes a diverse range of environmental goals including a water use reductions clause in sector strategies. Perhaps OW can participate and encourage broader application for these measures.
- We need to look at aquifer recharge. We need to look at low impact development systems that enable aquifer recharge and how we can encourage them.
- We need to identify places of the most significant waste of water, bad pipes, etc. Need to start using sophisticated sensors, etc.

- In water efficiency programs, most commonly, the waste occurs in landscaping. Landscaping use of water accounts for like 70% and often it is attributed to needless over-watering. Need smart residential water conservation systems.
- The point of entry for this to date has been sustainable infrastructure. Clearly, the actual water resources are a concern, especially considering the growth patterns.
- Examining the link between quantity and quality is key, and then we need to develop appropriate measures.

Managing in Times of More Limited Resources

Overview

A proactive and constructive assessment of the GAO comptroller's analysis of the nation's fiscal situation entitled, "Long-term Fiscal Challenge" speaks to the potential for budgetary constraints for the Office of Water and EPA as a whole. It may likely impact the ability to respond to emerging and unexpected spending needs in the water program. What are the different management questions we should be asking with smaller budgets? OW needs to be strategic and begin looking at ways to ensure sustainability. This includes finding severability, or products that can contribute in the long-term and should also include approaches that build ownership by civic organizations, businesses, states although this may require EPA to release some practices of business as usual. Several strategies for the future could include: 1) Information, both economic and environmental; 2) Partnerships – need to save resources and achieve our jointly desired results; 3) Capacity building – creating institutions that can take over, for example watershed groups or state entities; 4) Market-based approaches - can be very effective and efficient and are great when they can work; and 5) Leveraging existing resources to achieve the most despite the constraints. Finally, the importance of social marketing to influence people to make decisions that are pro-environment, and to influence how people build and plan their communities should not be discounted.

Discussion

- Revolving funds are a good example of systems that will persist.
- Can we write regulations that are "self-implementing" as opposed to the continual need for federal or state oversight?
- How important is research to Office of Water?
- To encourage a market-based model of sustainability – we can look at fee structures - fee for a service provided.
- Look to States for their best examples of fees and see how they have handled cutbacks and reduced staff.
- Simply looking for state partners to shoulder more of a burden has negative implications because states are already under pressure.
- The TRI Information model is very informative in terms of effectiveness of reducing the things at the top of list.

- We need to continue to build an understanding of ecosystems and what its degradation really costs us so that they are willing to pay.
- Become more information-based and use sensors to more vividly demonstrate actual environmental quality.
- There is potential to create systems that maintain themselves - need to make the right investments now.

Nanotechnology

Overview

There are significant challenges to addressing such a broad range of materials that can be considered nanotechnology and limitations of the current approaches. The special qualities that make these materials effective can also make them potential health and ecological risks, and possibly challenging our framework of toxicological and risk evaluation. Yet the potential opportunities to water quality from nanotechnology include special filters for water purification and sensors for water quality monitoring.

The main implications for strategic planning are the focus and resources of ongoing research. However, applications for filtration, at this point, do not alter the existing structure of the strategic plan in this cycle but we may want to build it into the next cycle. Some technologies pose the potential for highly efficient forward osmosis, instead of reverse osmosis, using active membranes or a series of channels that attract ions. Yet, the concurrent research question is: how much of the membrane is stable and will remain so? Certain materials such as C^{60} and zero-valent iron are being considered for contaminant capture in aquifers or landfill effluent. David presented both the vast opportunities and the unknown problems which must be addressed by new research.